

bart

SAN FRANCISCO BAY AREA RAPID TRANSIT



WEST CONTRA COSTA EXTENSION STUDY



FINAL REPORT



PREPARED FOR
THE BAY AREA RAPID TRANSIT DISTRICT
JUNE, 1983

WILBUR SMITH AND ASSOCIATES
DE LEUW CATHER AND COMPANY

Wilbur Smith and Associates, Inc.

282 SECOND STREET
2nd FLOOR
SAN FRANCISCO, CA. 94105
PHONE (415) 896-0670

CABLE WILSMITH
TELEX 57-3439

June 17, 1983

Mr. Richard Wenzel
June 17, 1983
Page Two

Mr. Richard Wenzel
Project Planner
Bay Area Rapid Transit District
800 Madison Street
Oakland, California 94607

Subject: Transmittal of Final Report
West Contra Costa Extension Study

Dear Mr. Wenzel:

We are pleased to submit to you our final report for the BART West Contra Costa Extension Study. This report combines and amplifies the evaluation and findings presented in our three interim reports. In addition, this report addresses the comments and inputs provided by BART staff, by representatives of the various governmental agencies, and by the public involved during the course of the study.

The study identified and developed 15 alternative BART extension alignments which could feasibly serve the study area. Capital cost estimates were developed for each of these alignments. The interim review of these alternatives allowed the identification of seven alternatives with significant merit to warrant in-depth consideration. For these promising alternatives, estimates of patronage, operating costs, and revenues were developed. The development of this data allows the evaluation of the productivity and cost-effectiveness of each of the alternatives.

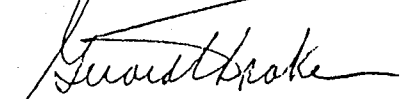
We have concluded that the alternatives offer significant tradeoffs of capital investment versus patronage and overall benefits to the study area. It is our hope that this study will provide adequate information relative to the alternatives and their implications to allow a proper assessment of these tradeoffs.

We would also like to gratefully acknowledge the assistance of Walter P. Quintin, Jr. and Earthmetrics, Incorporated. Mr. Quintin advised us on the development of operating strategies;

Earthmetrics staff prepared the initial environmental analysis.

Very truly yours,

Wilbur Smith and Associates


Gerard L. Drake
Vice President

GLD:rj
172740

TABLE OF CONTENTS

<u>CHAPTER</u>	<u>PAGE</u>
EXECUTIVE SUMMARY	i
Alignment Alternatives	ii
Key Physical Features	ii
Capital Costs	ii
Performance Indicators	ii
Farebox Recovery Ratio	iv
Operating Cost/Trip	iv
Environmental Factors	iv
Conclusions	iv
1 PROJECT BACKGROUND	1
1.1 BART Extension Policies	1
1.2 Study Purpose	2
1.3 Study Area Overview	2
1.4 The Study Process	3
1.5 Community Participation	4
2 ROUTE ALTERNATIVES	5
2.1 Criteria for Alternatives - Identification	5
2.2 Alternatives Description	8
2.3 Potential Station Locations	13
2.4 Storage Tracks and Crossovers	13
3 CAPITAL COSTS - FIXED FACILITIES	15
3.1 Unit Cost Assumptions	15
3.2 Right-of-Way Costs	16
3.3 Expanded Cost Estimates for Fixed Facilities	17
3.4 Identification of the Most Promising Alternatives	18
3.5 Comparison of Costs with State Route 4 Terminus	19
4 OPERATING PLANS	21
4.1 Operational Strategies	21
4.2 Service Level Assumptions	23
4.3 Travel Time and Average Speeds	24

TABLE OF CONTENTS (cont.)

<u>CHAPTER</u>	<u>PAGE</u>
4.4 Line-Haul Capacities	25
4.5 Fleet Requirements	26
4.6 Extensions Beyond State Route 4	28
5 PATRONAGE ANALYSIS	29
5.1 West Contra Costa Corridor Characteristics	29
5.2 Existing Transit Systems and Ridership	30
5.3 Travel Time Comparisons	31
5.4 Estimated 1995 Patronage for Alternative Alignments	31
6 OPERATING COSTS AND FARE REVENUE	37
6.1 Basic Assumptions	37
6.2 Operating Cost Analysis	38
6.3 Fare Revenue	39
6.4 Farebox Recovery	41
7 SUMMARY EVALUATION OF ALTERNATIVES	43
7.1 Physical Features	44
7.2 Capital Costs - Fixed Facilities	46
7.3 Operating Costs, Patronage and Revenues	48
7.4 Environmental Factors	48
7.5 Extensions North of State Route 4	51
APPENDIX	
Appendix A - BART Unit Cost Assumptions	
Appendix B - Segment Cost Estimates	
Appendix C - Station Parking Requirements	
Appendix D - Glossary	
Appendix E - Alignment and Profile Drawings	

TABLES

<u>Table</u>		<u>Page</u>
S-1	Summary Comparison of Alternatives Performance Indicators for Thru Service	iii
1	Alignment Alternatives	9
2	Station Accessibility Characteristics	14
3	Comparison of Fixed Facility Costs for Extension Alternatives	17
4	Capital Cost Summary - Most Promising Alternatives - State Route 4/Rodeo Terminus	20
5	Potential Service Strategies	21
6	Service Characteristics of Proposed Extension	24
7	Comparison of Running Times and Average Speeds to SR-4	25
8	Scheduled Running Times for Alternatives	26
9	Fleet Requirements for Extension Alternatives SR-4	27
10	Fleet Requirements for Through Service Beyond SR-4	28
11	Comparison of 1980 and 1995 Population Employment in West Contra Costa Communities	29
12	Comparison of Transit Travel Times-Current and with Extension, to Montgomery Station	32
13	Comparative Baseline Travel Forecasts for West Contra Costa Extension	33
14	1995 Forecast of Ridership By Route Alignment	34
15	1995 Station Patronage Forecast	35
16	Existing (May 1982) Access Modal Splits	36
17	Station Access Characteristics	36
18	Operating and Maintenance Unit Cost Assumptions	38
19	Comparison of Annual Operating Costs for Alignment and Service Options to SR-4	39
20	Costs of Thru Crockett Service	40

TABLES (cont.)

<u>Table</u>		<u>Page</u>
21	Gross Fare Revenues from Various Alignments (Annual)	41
22	Comparison of Farebox Recovery Ratios, By Alignment and Service Type to SR-4	42
23	Summary Comparison of Alternatives - Physical Features	45
24	Summary Comparison of Alternatives - Capital Costs	47
25	Summary Comparison of Alternatives - Operating Costs, Patronage and Revenues	49
26	Summary Comparison of Alternatives - Service Performance Indicators	50
27	Summary Evaluation of Alternatives - Environmental Sensitivity	52

ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
S-1	Alternative BART Rail Extensions	i
1	Study Area	1
2	Typical Cross Section At-Grade Alignment	6
3	Typical Cross Section Aerial Alignment	6
4	Segment Diagram	10
5	Feasible Combinations of Headway and Train Length to Meet Passenger Demand for a Ratio of Total to Seated Passengers of 1.5	27
6	Alternative BART Rail Extensions	43

EXECUTIVE SUMMARY

The BART West Contra Costa Extension Study evaluated the potential alternatives for an extension of BART's Richmond line into northwest Contra Costa County. The study involved the identification of all feasible alignment options and potential station sites. Each of the alignments was then analyzed in terms of capital costs, operating costs, patronage potential, and revenue potential.

A total of 15 alternative alignments were initially identified. The evaluation of these alignments with subsequent review by BART staff, by representatives of local governments in the study area, and by community interests, allowed the identification of seven alternatives which warranted further consideration.

Alignment Alternatives

The seven most promising alternatives are depicted in Figure S-1 and listed below:

- 1 - Southern Pacific
- 2 - AT&SF Railway
- 3 - Interstate-80
- 4 - San Pablo Avenue
- 5 - Rumrill/Hilltop/I-80
- 13 - Hilltop/I-80
- 14 - AT&SF Railway/I-80

A key conclusion of the study was that a logical northern terminus for an extension within the study area would be in the vicinity of the Interstate-80 and State Route 4 Interchange. This location was identified because it provides:

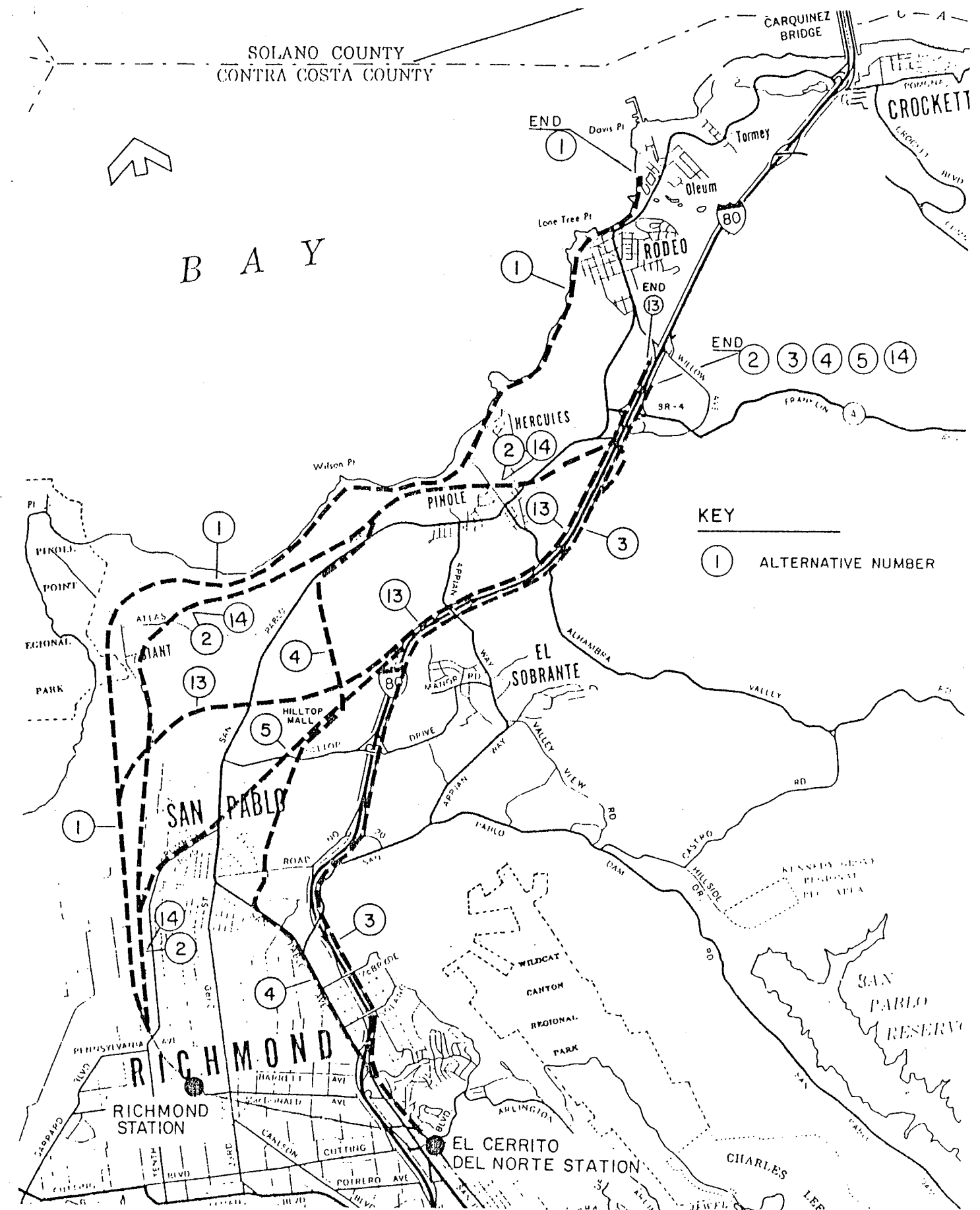
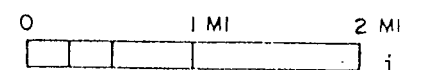


FIGURE S-1

ALTERNATIVE BART RAIL EXTENSIONS 1, 2, 3, 4, 5, 13 & 14
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



1. An excellent "intercept" point for Interstate-80 and State Route 4 travelers.
2. Sufficient undeveloped and relatively flat land for construction of a BART station and end-of-the-line train storage tracks.
3. Future flexibility for BART extension to the north or east.

Extensions further north to either Crockett or Cummings Skyway were found to be unattractive in terms of the potential for added patronage versus the added capital and operating costs. Thus, the seven selected alternatives were all modified to terminate at State Route 4 or at nearby Rodeo.

Key Physical Features

Those alternatives which extend north from the El Cerrito Del Norte Station pose two significant disadvantages compared to those which extend north from the Richmond Station.

1. Yard and Storage Facilities - The Richmond yard offers sufficient capacity to service the additional train maintenance and storage needs of the extensions. Extensions from El Cerrito Del Norte would, however, be too remote from the Richmond yard to operate efficiently. Thus Alternatives 3 and 4 would require a new yard facility which is proposed in the Refugio Valley east of Interstate-80 near State Route 4.
2. El Cerrito Del Norte Junction - Alternatives 3 and 4 require a junction of the existing BART tracks north of El Cerrito Del Norte and the extension tracks. This junction should be fully grade separated to avoid operational conflicts, requiring a vertical crossover of the existing BART tracks. The remaining section of the Richmond line would then become a separate terminal, with the new terminus near State Route 4.

Capital Costs

The total capital costs of the alignment alternatives including vehicles would range from \$175 million to \$449 million. The most costly alternatives, Alternative 4 (\$449 million) and Alternative 5 (\$337 million) require extensive tunnel construction to gain access to Hilltop Mall. Alternatives 1, 2 and 14 require the least costs (\$175-\$176 million) because of their potential use of the relatively flat and unobstructed path created by the Southern Pacific and Santa Fe Railroads. Alternative 13 is the only alternative which provides a station at Hilltop Mall without the extensive tunnelling required in Alternatives 4 and 5. Its capital cost estimate of \$203 million is competitive with the railroad alignments, as is the cost of Alternative 3 - Interstate-80 (\$223 million).

The relative attractiveness of Alternative 13 depends upon the uncertain assumption that CalTrans would not implement a presently planned HOV lane project on I-80, and that the BART line extension could be accommodated within the existing I-80 right-of-way. Additional construction cost and some right-of-way acquisition would be necessary if both projects were implemented. In this case, substantial additional costs would be incurred to create a feasible alignment.

Performance Indicators

A summary comparison of the performance of the alternatives in terms of various indicators or measures of cost effectiveness and productivity is shown in Table S-1.

Patronage - The alternatives would differ greatly in terms of total future transit ridership. Alternatives 1, 2 and 14 would have the least ridership potential, 5,200 - 9,800 one-way passenger trips. These alternatives follow the Southern Pacific

Table S-1
SUMMARY COMPARISON OF ALTERNATIVES
PERFORMANCE INDICATORS FOR THRU SERVICE
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	EXTENSION FROM	NORTH (1) TERMINUS	LENGTH (Miles)	NUMBER OF STATIONS	NUMBER OF TRAINS/CARS REQUIRED (7)	ONE-WAY DAILY (3) PASSENGER TRIPS	CAPITAL COSTS (1982 \$ Millions)			FIXED FACILITY (4) COST PER MILE (1982 \$ Millions)	ANNUAL OPERATING COST (1982 \$ Millions)	FAREBOX RECOVERY RATIO (5)	OPERATING COST/TRIP
							FIXED FACILITIES	CARS	TOTAL				
1 - Southern Pacific	Richmond	Rodeo	9.9	4	2/24	5,200 - 8,200	\$146	\$29	\$175	\$14.7	\$ 6.9	23	\$ 6.59
2/14 - AT&SF Railway (2)	Richmond	SR-4	8.2	3	2/27	6,400 - 9,800	144	32	176	17.6	6.8	28	5.38
3 - Interstate-80	El Cerrito	SR-4	8.1	3	3/33	8,400 - 13,200	183	40	223	22.6	6.2	40	3.66
4 - San Pablo Avenue	El Cerrito	SR-4	8.9	4	3/39	10,000 - 16,000	402	47	449	45.2	7.1	42	3.46
5 - Rumrill/Hilltop/I-80	Richmond	SR-4	7.6	4	3/38	10,000 - 15,600	291	46	337	38.3	6.7	43	3.31
13 - Hilltop/I-80	Richmond	SR-4	8.0	4	3/32	7,800 - 12,400	165 (6)	38	203 (6)	20.6	6.9	33	4.33

(1) For purposes of comparison all alternatives were terminated at either State Route 4 or Rodeo.

(2) Between Richmond and State Route 4 Alternatives 2 and 14 have identical alignments.

(3) Includes existing BART patrons ("old riders").

(4) Fixed facility costs only, excludes vehicles.

(5) Ratio of fare revenues to operating cost.

(6) Cost estimate assumes CalTrans does not implement I-80 HOV lane.

(7) Trains required were developed assuming 10 car trains and 15 percent spare requirements.

and Santa Fe Railroad alignments which serve the extreme western portions of the study area and are removed from Interstate-80 and much of the study area population. The greatest patronage potential, 10,000 - 16,000 one-way passenger trips, would be associated with Alternatives 4 and 5 which were specifically planned to serve central San Pablo, Hilltop, Pinole and the State Route 4 area directly. The high level of access provided by these alternatives has to be weighed against their higher capital costs. Alternatives 3 and 13 would provide less access to the developed southern portion of the study area than Alternatives 4 and 5, as is reflected by lower forecast patronage levels.

Farebox Recovery Ratio

The ratio of estimated fare revenues to operating cost is an important indicator of overall system productivity. Currently the BART system recovers 45 percent of the system's operating expense from passenger revenues. The estimated farebox recovery for the proposed extension alternatives ranges from 23 to 43 percent. Alternatives 1, 2 and 14 would have a considerably lower farebox recovery ratio than any of the other alternatives.

Operating Cost/Trip

Currently BART's operating cost per passenger mile is 16.4 cents. A typical longer commute trip (the type expected on the West Contra Costa Extension) is forecast to cost between \$3.30 and \$6.60 to provide; in contrast, a similar trip on today's system would cost about \$3.30 to provide. Thus, the extension would tend to raise the cost of the average trip. And again, the performance of Alternatives 1, 2, and 14 is significantly poorer than that of the other alternatives.

These operating costs reflect a "thru" service operating concept where trains would operate directly to San Francisco/Daly City from the State Route 4 terminal. The costs also reflect headways or service frequencies at levels consistent with current BART service policy, with service every 15 minutes from 6 A.M. to 7 P.M. and 20 minute service evenings and weekends.

A "shuttle" service concept was also evaluated, which would involve trains operating on the extension only. Through passengers would have to transfer at the southern terminus of the extension, either the Richmond or El Cerrito Del Norte Stations. The shuttle service concept represents reduced service convenience for extension patrons which would be reflected in reduced patronage as compared with through service. A substantial operating cost savings of approximately \$2 million per year could be achieved by using shuttle service rather than through service.

Environmental Factors

A preliminary environmental assessment of the alternatives was completed to discern any significant environmental impacts which would be associated with each alternative. None of the identified potential impacts were of a severity which would suggest eliminating any of the alternatives. Alternatives 3, 4, and 13, which require earth cuts and fills, would have visual and geological impacts. The aerial structure required with Alternative 4 along San Pablo Avenue would have adverse traffic and noise impacts. Potential displacement of businesses and residences were negligible for all the alternatives.

Conclusions

The alternatives suggest that significant trade-offs are available in terms of the capital costs initially invested in

a BART extension and the ultimate patronage or total benefit derived from the alternative. Use of either the Southern Pacific or Santa Fe alignments (Alternatives 1, 2 and 14) would involve the least investment in fixed facilities but also would yield low productivity in terms of patronage and revenue. The greatest productivity would be derived from Alternatives 4 and 5, which would generate 70 percent more patronage than Alternatives 1, 2 and 14, but would require an additional \$161 to \$274 million in total capital costs, or 91 to 157 percent more capital costs than Alternatives 1, 2 and 14. Alternatives 3 and 13 also offer increased productivity as compared with Alternatives 1, 2 and 14, generating 40 percent more patronage. These alternatives would involve additional total capital costs of \$27 to \$48 million or 16 to 27 percent greater costs than those associated with Alternatives 1, 2 and 14. A key concern related to Alternative 13 is its conflict with the planned Interstate-80 carpool/bus lane. Alternatives 3 and 4 have the disadvantages related to an extension from El Cerrito Del Norte, namely the need to construct a new yard facility and a grade-separated junction with the existing BART tracks.

1. PROJECT BACKGROUND

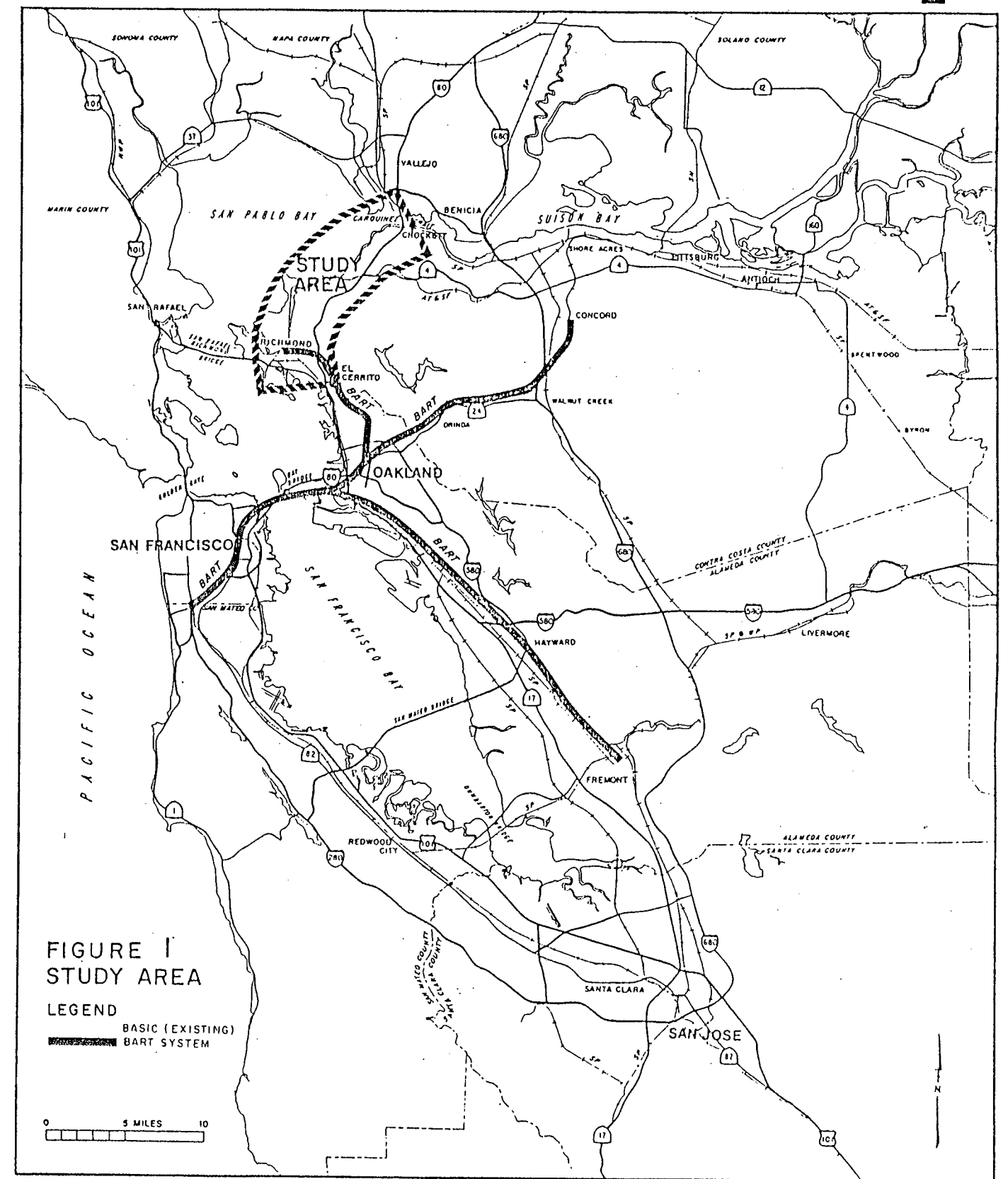
The West Contra Costa Extension Study explores the implications of a northward extension of the Bay Area Rapid Transit (BART) District's Richmond Line into the northwestern portions of Contra Costa County. The study area, its relationship to the San Francisco Bay Region, and the existing BART system is presented in Figure 1. The study focused on an area extending north from Richmond and El Cerrito to the Carquinez Strait. This area includes portions of Richmond and El Cerrito as well as San Pablo, Pinole, Hercules, Crockett, Rodeo and unincorporated areas of the County.

1.1 BART Extension Policies

In 1957 the San Francisco Bay Area Rapid Transit Commission presented its recommendations to the State Legislature for a five county, 370-mile rapid transit system. Subsequently, three of the five counties, Contra Costa, Alameda and San Francisco voted to join the proposed Bay Area Rapid Transit District (BARTD). The BART Plan was modified to provide services in the three county area. The first phase of development was the basic 71-mile system now in operation. Future phases were to provide service extensions of the Concord Line from Concord to Pittsburg and Antioch and of the Fremont Line to both South Fremont/Warm Springs and Pleasanton/Livermore.

In the early 1970's BART participated in several extension studies which investigated the feasibility of extending its lines within the three-county district as well as into San Mateo County. In 1979, an additional study was conducted of an extension of the Fremont line to the Warm Springs area.

In 1980, the BART Board adopted a policy statement on



BART extensions.⁽¹⁾ This statement established a four-phase program for completion of extensions to Antioch, Livermore, South Fremont/Warm Springs and to the San Francisco Airport. The policy states that the BART system would be expanded incrementally with concurrent construction of various extension segments.

More recently the BART Board recognized the need to develop definitive information relative to the feasibility of a West Contra Costa Extension. Up until this time, almost no reliable information was available upon which to judge the merits or feasibility of a West Contra Costa Extension. This study would provide an information base comparable to that now available or under development for the other potential extensions.

1.2 Study Purpose

The objectives of the West Contra Costa Extension Study were to:

- Define practical alignment alternatives extending north from either the Richmond or El Cerrito Del Norte BART Stations;
- Identify potential locations for passenger stations and storage yards for each alternative alignment;
- Establish the service characteristics of each alternative to the extension and related patronage potentials;
- Analyze the comparative impacts of the alternatives on passenger accessibility, and determine patron access needs; and

⁽¹⁾ BART Board of Directors, Resolution No. 2815 - A Policy on Extension Right-of-Way and Expenditures, April 14, 1980.

- Provide reliable preliminary estimates of implementation capital and operating costs, and revenues.

The study was designed in a manner which would facilitate active review of the study efforts by local government officials and staff, by concerned community interests, and by BART staff at several points during the study process. In order to assure that all identified alternatives were given equal consideration, a uniform set of concept design guidelines, unit capital cost factors and operating cost factors were developed and utilized to evaluate each alignment concept.

1.3 Study Area Overview

In 1980 the study area had a population of approximately 145,000 persons. The Association of Bay Area Governments (ABAG) has projected (ABAG Projections-79) that by 1995 the total study area population will grow to 175,000, a 21 percent population increase. Richmond contains the densest concentration of residents in the corridor. There is also considerable commuting from the communities north of Richmond to Oakland and San Francisco. These communities -- San Pablo, Pinole, Hercules, Rodeo, and Crockett -- are principally suburban in nature and rely on other communities for most of their employment.

The northern communities contain a considerable amount of developable open space. Much of this land is already slated for residential, commercial, and light industrial or office development. These projects include the Hercules Industrial Park, the planned office-residential development surrounding Hilltop Mall and the proposed development of the Chevron/Standard Oil property.

Interstate-80 is the major north-south travel facility in the area serving over 100,000 vehicles per day in the vicinity

of Richmond. This key link between the Bay Area, Sacramento and points east is also an important regional commuter route. This route is often heavily congested during peak morning and afternoon commute periods. Commute traffic is generated by residents of both Contra Costa and Solano Counties. State Route 4 is the major east-west highway link in northern Contra Costa.

Two major railroad rights-of-way traverse the study area. The Southern Pacific Railroad extends through Richmond to the Bayfront, and parallels the shoreline up to and along the Carquinez Strait. The Atchison Topeka and Santa Fe Railway parallels the Southern Pacific until turning to the east near State Route 4.

Currently BART operates two express bus routes, one of which operates between the El Cerrito Del Norte station and Pinole, and the other between El Cerrito Del Norte and Rodeo. The current ridership of these lines is approximately 750 passengers per weekday. To further encourage the use of transit and high occupancy vehicles (HOV) in the Interstate 80 corridor, CalTrans is proposing to develop an exclusive HOV lane paralleling the existing Interstate-80.

The West Contra Costa County study area is a growing area with a pattern of long distance commuting to the major Bay Area employment centers. This type of growth increases the need for alternative long-distance travel options to the congested Interstate-80 corridor.

1.4 The Study Process

The study involved three major analytical tasks, as follows:

Task 1 - System Conceptual Design - In this task the full range of route alignment alternatives extending north from the Richmond and El Cerrito Del Norte Stations was identified.

Candidate locations for station and yard facilities were also defined. Specific drawings of the alignments in terms of their route, vertical profile and cross-section were prepared (See Appendix E).

Task II - Revenue Service and Patronage Analysis - The purpose of this task was to define the characteristics of the BART service which could be provided on any of the extension options in terms of service frequency, capacity (length of trains) and service type (through service versus a local shuttle service, for example). Estimates of potential patronage were then prepared based upon the proposed quality of service, the anticipated growth of the study area, and the accessibility of the various potential station locations.

Task III - Cost/Revenue Analysis - This task required the development of estimates of the capital costs and operating costs associated with the alternative alignments. A uniform set of specially developed unit cost factors was utilized to develop the costs associated with each alternative. This approach assured that the comparison of one alternative with another would be presented in an accurate and valid fashion. The final step in this analysis was to estimate the fare revenue to be generated by patronage of the extension and to determine the ratio of revenue to operating costs. This ratio provides a measure of service productivity which can be compared directly with the productivity estimates for other extensions and with the productivity of the existing BART system.

At the end of each task an interim report was prepared and submitted for review by BART, the local governmental agencies, and interested community members in the study area. This process allowed a means of screening all the identified alternatives into a group of "most promising" alternatives which could be considered in greater detail. A total of 15

alternatives were identified during the course of the study. Of these, seven alternatives were found to have special promise worthy of further consideration.

1.5 Community Participation

The study design allowed for active involvement of the communities in the study area. At the onset of the study in December 1982, special community meetings were held in Pinole and in San Pablo. Members of local community governments, and other interested community members were briefed on the study and presented with a preliminary discussion of the alignment options. These meetings resulted in the identification of new alternatives, and the refinement of the earlier identified alternatives to improve accessibility and reduce conflicts with local development plans.

During the study each of the community representatives and interests was given the opportunity to review and comment on each of the three interim reports. The inputs received from these review efforts have been incorporated into this final project report.

2. ROUTE ALTERNATIVES

This portion of the study involved the identification of the full range of basic route alignment alternatives for a feasible BART extension from the existing Richmond and/or El Cerrito Del Norte BART Stations in West Contra Costa County to Crockett. Additionally, candidate locations for stations were determined for each alternative alignment. Potential sites for the storage and maintenance yard facilities that would be required were also located.

The route alignments were defined in terms of various route segments. Various combinations of the segments define each alternative alignment. Individual segments and given combinations of segments are often common to several alternatives. The use of route segments to define the alternatives simplifies the overall process of developing and evaluating alternatives. New alternatives can be easily reviewed by combining the appropriate segments.

2.1 Criteria for Alternatives Identification

The primary objective in the selection of candidate alignment segments was to develop alternatives which maximized service to the developed and developing portions of the study area. The alternatives should also exploit the use of available publicly and privately owned rights-of-way to the maximum extent possible. Railroad rights-of-way are an example of those which could provide a corridor for BART development.

Given this overall objective, the selection of the candidate alignment segments was based on five critical factors:

1. Right-of-way availability potential.
2. Conformance to BART design criteria and standards.

3. Potential environmental impacts such as displacement of housing and/or businesses.
4. Significant obstacles or routing feasibility problems from a technical standpoint.
5. Potential conflicts with existing rail operations, street or highway traffic, or with major utilities and pipelines.

Within the alignment segments, potential station sites were identified based on four evaluation factors:

1. Station accessibility via bus, auto, bicycle and pedestrian modes.
2. Service to potential trip generators.
3. Land availability.
4. Sufficient station spacing for high speed operation.

Emphasis was given in the right-of-way availability evaluation to maximize the use of publicly owned land and to identify certain privately owned parcels which may have potential for interim lease until BART construction commences.

To provide conformance with BART design standards, the following design criteria were used in developing the alternatives.

2.1.1 Alignment and Profile Criteria

To maintain a fully grade-separated exclusive right-of-way for double tracks, a minimum right-of-way width of 40 feet is required for at-grade alignment and 26 feet is required for BART aerial structure. Right-of-way requirements of the at-grade and aerial BART cross-sectional configurations are illustrated in Figures 2 and 3.

FIGURE 2
TYPICAL CROSS SECTION
AT-GRADE ALIGNMENT

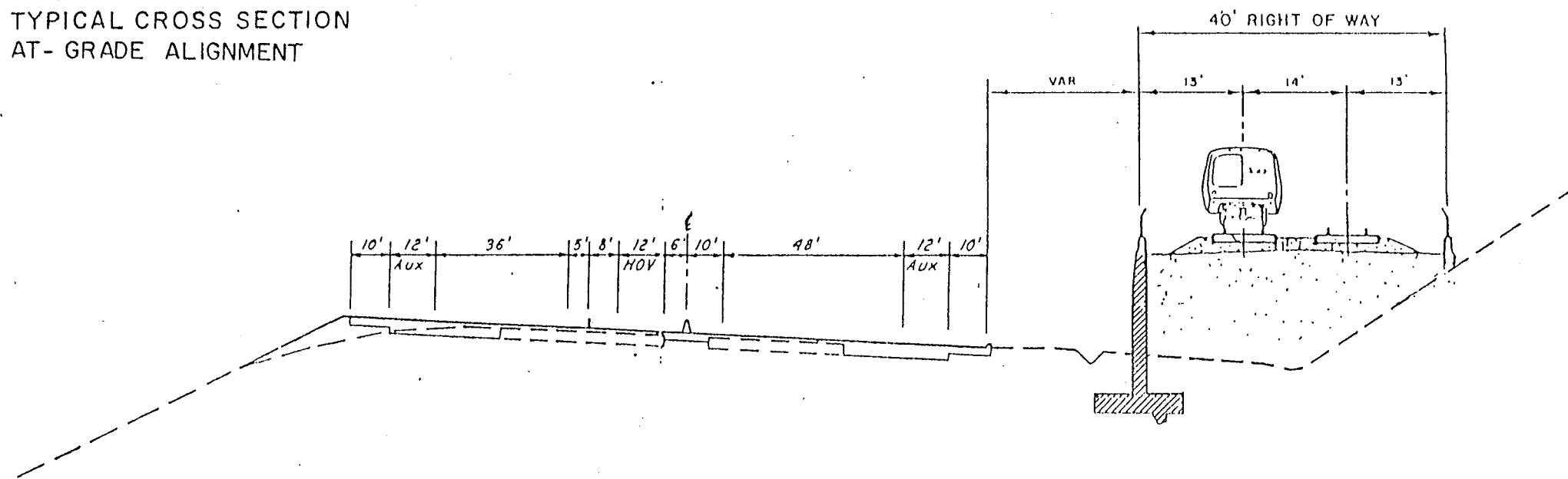
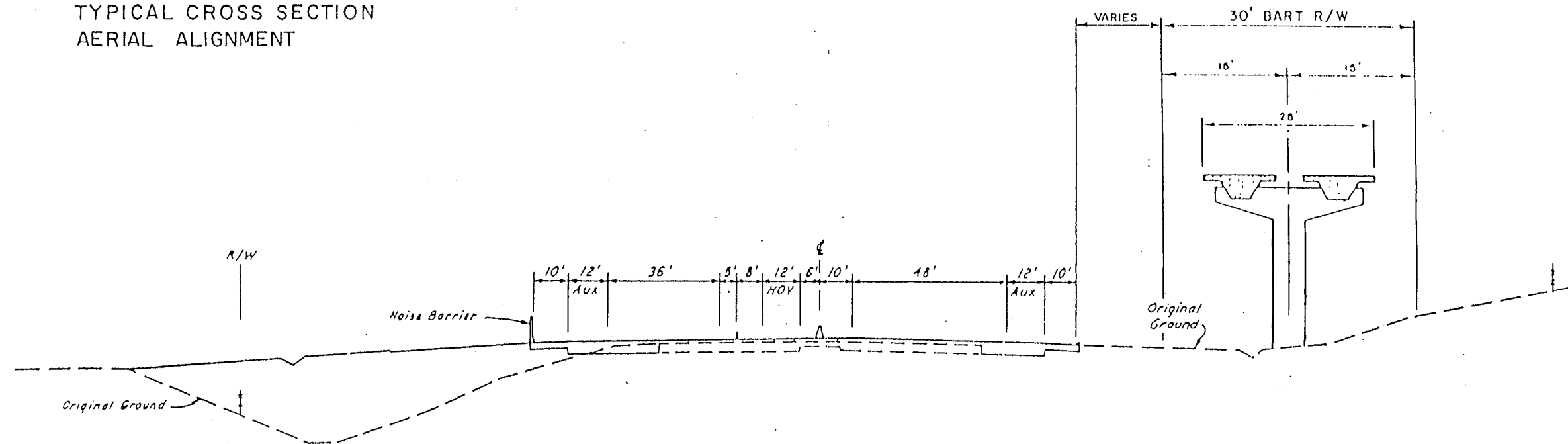


FIGURE 3
TYPICAL CROSS SECTION
AERIAL ALIGNMENT



To maintain reasonable operating speeds BART uses a desired maximum profile gradient of 3.0 percent, and an absolute maximum of 3.5 percent. Considering the varied and hilly terrain of West Contra Costa, the desired maximum profile gradient of 3.0 percent could not be maintained in every alignment segment. Use of the maximum grade of 3.5 percent was required in some areas. In order to reduce steep transitions between grades in conformance with the BART criteria for vertical curves, and for the maximum rate of change of grade, aerial structures of exceptional heights are required, in combination with subways. Even so, in some areas the design train velocity is only 30 MPH.

Horizontal curves were kept within the minimum acceptable radius of 1,000 feet. Reverse curves and compound curves were laid out with the consideration of providing spiral transition curves to run off the superelevation and also of providing at least the absolute minimum tangent length of 100 feet between curves.

The minimum vertical clearance to the underside of BART aerial structures was established in conformance with the California PUC regulations, as follows:

- 23' - 0" feet above railroad
- 15' - 0" above highways; and
- 16' - 6" above Interstate Highways.

2.2.2 Stations and Yard Facilities

Station requirements were developed in conformance with BART design standards for aerial, at-grade, and subway station design. Requirements for new access roadways and parking areas were based on specific site characteristics and on estimates of station patronage and mode of access.

Requirements for yard facilities and other train storage facilities were developed in cooperation with BART system operations staff. It was determined that these requirements would vary for extensions from the El Cerrito Del Norte Station versus those extending from the Richmond Station as follows:

Extensions north of the Richmond Station could make use of the existing BART yard at Richmond and would not require an additional yard. A tail track 3000 feet in length for train storage, however, would be required beyond the last station on the alignment.

Extensions north of the El Cerrito Del Norte Station would require a new yard and train storage facility, preferably near the northern terminus of the extension. In this case a 1000 foot tail track would be required beyond the last station.

To facilitate operations, the BART extension trackage should also include evenly spaced train storage tracks and crossover tracks, so that out of service trains can be either bypassed or moved off the mainline tracks. It is important to note that such facilities are generally difficult to provide on alignments through hilly terrain.

2.2.3 El Cerrito Del Norte Junction

An extension north of the El Cerrito Del Norte station would require the new BART tracks to join the existing BART tracks between El Cerrito Del Norte and Richmond just north of the El Cerrito Del Norte Station. This junction could be constructed in either an at-grade crossover or a full grade-separated configuration. For the purposes of this study a

full grade separated crossover of the northbound Richmond tracks by the southbound extension trackage was assumed. This assumption is consistent with the design philosophy used in planning the existing BART system, and eliminates potential operating conflicts and problems which could be associated with an at-grade crossing.

2.2 Alternatives Description

The original planning and engineering efforts performed by the consultant team generated twelve alternatives. The review of these alternatives by BART staff and by local community interest generated three additional alternatives and prompted various modifications to the original concepts. Thus, the alternatives represent a full range of BART extension concepts which are feasible from an engineering and planning standpoint. Table 1 presents a summary description of the 15 alternatives. Figure 4 defines and locates the various route segments which constitute each alternative alignment. By referring to the segment combination description of each alternative as given in Table 1, the route alignment can then be traced in Figure 4. A description of the key features of each alternative follows:

Alternative 1. This alignment would extend from the Richmond Station to a northern terminus at Crockett via the Southern Pacific right-of-way. Five stations would be provided, with stations at Parr Boulevard and Atlas Road in Richmond, and stations serving Pinole, Rodeo and Crockett. In order to avoid conflicts with utilities and spur tracks within the Southern Pacific right-of-way, a substantial portion of this alignment would have to be on elevated aerial structure. This route would have a total length of 13.3 miles plus a 3000 foot long tail track along the Crockett waterfront. The Crockett Station and

the tail track would require a significant land area in the waterfront industrial area immediately under the Carquinez Strait Bridges. It is important to note that the Southern Pacific right-of-way is subject to chronic slide conditions. In these areas the BART alignment would have to be protected by a box structure.

Alternative 2. This alternative would also extend from the Richmond Station to Crockett. The route would parallel the Santa Fe right-of-way from Richmond to the vicinity of State Route 4 and Interstate-80. At State Route 4 the route turns to the northwest via an abandoned railroad right-of-way through the proposed Hercules Industrial Park area. The alignment could be constructed largely using an at-grade BART configuration, as utility and railroad spur conflicts are not extensive. The route, however, may conflict with the Hercules Industrial Park development plans. Five stations would be provided along the 13.6 mile route with stations in Richmond, Pinole, near State Route 4/Interstate-80, Rodeo and Crockett. A 3000 foot tail track would be provided in Crockett as in Alternative 1.

Alternative 3. This alternative would parallel the east side of Interstate-80 from the El Cerrito Del Norte Station to a station near the Cummings Skyway Interchange, a distance of 10.9 miles. The extension north of El Cerrito Del Norte requires that a vertically separated crossover of the existing northbound tracks to Richmond be provided as previously discussed. The alignment traverses very rugged, hilly terrain by the freeway, and would require extensive use of aerial structures and earth cuts and fills. The grades approaching the Hilltop Drive Interchange from the south would equal 3.5 percent, the maximum allowable BART design gradient. The northern approach to this interchange would require a long 2.6 percent grade. Four stations would be provided in the freeway interchange areas at Hilltop,

Table 1
ALIGNMENT ALTERNATIVES
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	SEGMENT COMBINATION	EXTENSION FROM	TERMINATION POINT	TOTAL LENGTH*		TAILTRACK LINEAR FEET	NUMBER OF STATIONS
				LINEAR FEET	MILES		
1 - Southern Pacific	1A+1B+1C+1D	Richmond	Crockett	70,000	13.3	3,000	5
2 - AT&SF Railway	2A+2B+2C+2D+2E+Y2+1D	Richmond	Crockett	71,500	13.6	3,000	5
3 - Interstate-80	3A+3B+3C	El Cerrito	Cummings Skyway	57,300	10.9	1,000	4
4 - San Pablo Ave.	4A+4B+2C+2D+2E+Y2+1D	El Cerrito	Crockett	75,000	14.2	1,000	6
5 - Rumrill/Hilltop/ I-80	2A+5A+5B+3B+3C	Richmond	Cummings Skyway	54,300	10.3	3,000	5
6 - AT&SF/Hilltop Southern Pacific	2A+5A+4B+2C+X+1B+1C+1D	Richmond	Crockett	65,500	12.4	3,000	6
7 - AT&SF/Southern Pacific	2A+2B+2C+X+1B+1C+1D	Richmond	Crockett	67,500	12.8	3,000	5
8 - Southern Pacific/ AT&SF	1A+1B+Z+2E+Y2+1D	Richmond	Crockett	74,000	14.0	3,000	5
9 - I-80/Southern Pacific	3A+3B+Y1+Y2+1D	El Cerrito	Crockett	71,000	13.5	1,000	5
10 - San Pablo Ave/ Southern Pacific	4A+4B+2C+X+1B+1C+1D	El Cerrito	Crockett	71,000	13.5	1,000	6
11 - AT&SF/Hilltop/ Southern Pacific	2A+5A+4B+2C+2D+2E+Y2+1D	Richmond	Crockett	69,500	13.2	3,000	6
12 - AT&SF/Hilltop/ Southern Pacific	2A+5A+5B+Y1+Y2+1D	Richmond	Crockett	68,000	12.9	3,000	6
13 - Hilltop/I-80	1A/1+13	Richmond	State Route 4	42,000	8.0	3,000	4
14 - AT&SF/I-80	2A+2B+2C+2D+2E+1+Y4+Y5+3C/2	Richmond	Cummings Skyway	61,300	11.6	3,000	4
15 - San Pablo Ave/ I-80	4A+5B+3B+3C	El Cerrito	Cummings Skyway	59,800	11.3	1,000	5

Note: Alignment Alternatives extending from El Cerrito are serviced by new storage yard.

*New construction w/o tail tracks and w/o storage yard.

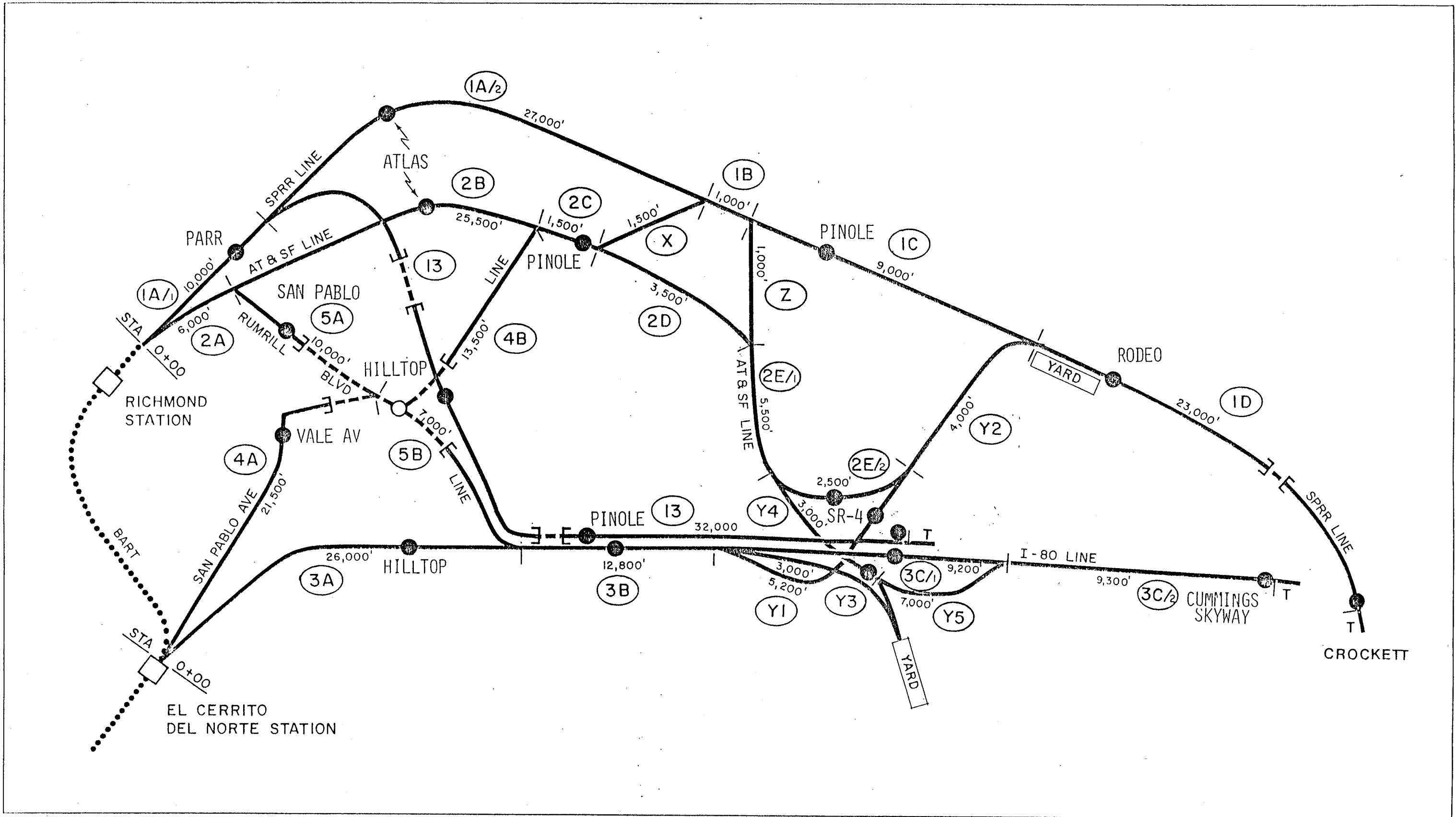


FIGURE 4
 SEGMENT DIAGRAM
 WEST CONTRA COSTA COUNTY BART EXTENSION STUDY

- LEGEND
- Existing Line
 - Existing Station
 - Proposed At-Grade/Aerial Station
 - Proposed Subway Station
 - Proposed At-Grade/Aerial Line
 - Proposed Subway Line
 - Tail Track
 - Segment Identifier

REV. 2/3/83

NOT TO SCALE

Pinole, State Route 4, and Cummings Skyway. A maintenance and train storage yard would be provided east of the State Route 4/ Interstate-80 interchange in the Refugio Valley, and a 1000 foot tail track would be provided immediately north of the Cummings Skyway Station.

Alternative 3 is the only alternative which would cross the Hayward fault with an aerial structure. The trackage would have to be specially designed to accommodate creepage of the fault.

Alternative 4. Alternative 4 extends from the El Cerrito Del Norte Station to Crockett via San Pablo Avenue and the Hilltop Mall. The route utilizes an aerial structure over the median of San Pablo Avenue. Near Church Lane in the City of San Pablo, the alignment extends through privately owned lands to the Hilltop Mall. The approach to Hilltop Mall requires the use of tunneling and cut and cover construction. North of Hilltop Mall, the alignment would utilize aerial structures when traveling through the Chevron properties before joining San Pablo Avenue. The aerial structure would follow the median of San Pablo Avenue to Pinole and would then join the Santa Fe right-of-way. From that point north the alignment would be identical to that of Alternative 2 with a terminus in Crockett. Six stations would be provided along the 14.2 mile route with stations in San Pablo, Hilltop, Pinole, State Route 4, Rodeo, and Crockett where a 1000 foot tail track would be provided. A maintenance yard would be provided in Refugio Valley.

Alternative 5. This alignment would extend from the Richmond Station to Hilltop Mall and then to the Interstate-80 corridor with a terminus at Cummings Skyway. The route would briefly follow the Santa Fe right-of-way to Rumrill Boulevard in San Pablo. An aerial structure would be used in the median of Rumrill Boulevard. Near the Contra Costa College Campus the alignment would enter a tunnel sloping upward towards Hilltop Mall at a 3.0 percent grade. Beyond Hilltop Mall, the align-

ment would require both aerial structure and a short tunnel to join Interstate-80. This alignment follows the east side of Interstate-80 to a terminus at Cummings Skyway for a total distance of 10.3 miles. Stations would be provided at San Pablo, Hilltop, Pinole, State Route 4, and Cummings Skyway where a 3000 foot tail track would be required.

Alternative 6. This route combines features of Alternatives 1, 4, and 5. The route to Hilltop Mall via the Santa Fe right-of-way and Rumrill Boulevard is as proposed in Alternative 5. After Hilltop Mall, however, the alignment would be similar to that of Alternative 4, extending to Pinole through the Chevron properties. In Pinole the alignment joins the Southern Pacific right-of-way to continue north to a terminus in Crockett, similar to Alternative 1. Six stations would be provided including San Pablo, Hilltop, Pinole (2 stations), Rodeo and Crockett (3000' tail track). The total length of this extension would be 12.4 miles.

Alternative 7. This alternative is a combination of Alternatives 1 and 2. The route would extend north of the Richmond Station via the Santa Fe alignment and would then shift to the Southern Pacific alignment in Pinole. The alignment then would continue north to Crockett in the Southern Pacific right-of-way, a total distance of 12.8 miles. Station locations would include San Pablo, North and South Pinole, Rodeo, and Crockett. A total of five stations and a 3000 foot tail track at Crockett would be provided.

Alternative 8. This alternative also represents a combination of Alternatives 1 and 2. In this case, the line would extend from Richmond to Pinole via the Southern Pacific right-of-way. In Pinole it would shift to the Santa Fe right-of-way, approach Interstate-80, but double back to the Southern Pacific right-of-way to an eventual terminus in Crockett consistent with

Alternative 2. This alternative totals 14.0 miles in length with 5 stations and a 3000 foot tail track in Crockett. Stations would be provided in Richmond, San Pablo, Pinole, Rodeo and Crockett.

Alternative 9. This alternative extends north from El Cerrito Del Norte and the Interstate-80 corridor to State Route 4. At State Route 4 it would turn northwest to the alignment provided for Alternative 2, extending through Hercules to the Southern Pacific right-of-way, and then terminating in Crockett for a total distance of 13.5 miles. Five stations would be provided with stops at Hilltop, Pinole, State Route 4, Rodeo and Crockett. A yard would be required either at the Refugio Valley site or in Rodeo near the Southern Pacific tracks. A 1000 foot tail track would be provided at Crockett.

Alternative 10. This alignment is a variation of Alternative 4. It would extend from the El Cerrito Del Norte Station to Pinole via San Pablo Avenue and the Hilltop Mall. In Pinole the alignment would directly join the Southern Pacific alignment extending the full distance to Crockett (13.5 miles). A yard would be required in Rodeo and a 1000 foot tail track at Crockett. Stations would be in San Pablo, Hilltop, North and South Pinole, Rodeo and Crockett.

Alternative 11. This alignment is a variation of Alternative 6. The basic route extends from Richmond to Hilltop Mall via Rumrill Boulevard and then to Pinole via the Chevron properties. In Pinole the alignment reverts to the routing of Alternative 2, along the Santa Fe and Southern Pacific rights-of-way, ultimately terminating at Crockett. A total of six stations would be provided including San Pablo, Hilltop, Pinole, State Route 4, Rodeo and Crockett. The route would extend 13.2 miles plus a 3000 foot tail track at Crockett.

Alternative 12. As in the alignment proposed for Alternative 5, Alternative 12 extends from Richmond to Hilltop via

the Santa Fe right-of-way and Rumrill Boulevard and then continues to the east side of Interstate-80. The alignment would shift from the Interstate-80 corridor near State Route 4 and join the Southern Pacific right-of-way in Rodeo, with a northern terminus in Crockett. Station locations are proposed at San Pablo, Hilltop, Pinole, State Route 4, Rodeo and Crockett for a total of six stations in 12.9 miles. A 3000 foot tail track would be provided beyond the Crockett Station.

Alternative 13. This alternative enters Hilltop Mall from Richmond via an alignment departing from the Southern Pacific right-of-way, over-crossing the Santa Fe right-of-way and traversing the Chevron properties to Hilltop Mall. Some tunneling and aerial structure is required to traverse the hilly terrain in this area. Beyond Hilltop Mall, the alignment would travel along the west side on Interstate-80 and would terminate near State Route 4. The route represents the shortest of the alternatives, 8.0 miles in length. Stations would be provided in north Richmond, Hilltop, Pinole, and at State Route 4 where a 3000 foot tail track would be provided.

Alternative 14. This alternative extends from Richmond to Interstate-80 via the Santa Fe alignment. Near State Route 4 the alignment follows Interstate-80 to a terminal station at Cummings Skyway where a 3000 foot tail track would be provided. Three other stations would be located at San Pablo, Pinole, and State Route 4, along an 11.6 mile total route.

Alternative 15. Extending from the El Cerrito Del Norte Station, this alternative represents a variation of the Interstate-80 alignment (Alternative 3) that is designed to provide direct access to Hilltop Mall via the San Pablo Avenue alignment provided in Alternative 4. From Hilltop Mall this alignment would return to and parallel the east side of Inter-

state-80 up to its termination at the Cummings Skyway Interchange. Stations would include San Pablo and Hilltop, as well as the Pinole, State Route 4 and Cummings Skyway stations along Interstate-80. This route extends 11.3 miles and would require a yard in the Refugio Valley and a 1000 foot tail track.

2.3 Potential Station Locations

The descriptions of the alternative alignments identified a number of potential station locations. Table 2 provides a summary of the notable accessibility characteristics of each station. The precise location and configuration of each station would tend to vary with different BART alignments but the general accessibility of each station is constant except as noted.

2.4 Storage Tracks and Crossovers

Alternatives 3, 4, 5, 6, 9, 10, 11, 12, 13 and 15 all traverse major areas of hilly terrain. Such terrain would complicate the ability to produce well located storage tracks and crossovers along the extension. Alternatives 1, 2, 7, 8, and 14 follow relatively level routes offering better opportunities for providing the necessary storage and crossover tracks.

Table 2
STATION ACCESSIBILITY CHARACTERISTICS
BART WEST CONTRA COSTA EXTENSION STUDY

STATION SITE	CHARACTERISTICS			
	<u>Land Availability & Parking</u>	<u>Street Access & Circulation</u>	<u>Transit Service</u>	<u>Proximity to Existing Housing/Jobs</u>
VALE AVENUE	Good	Good from San Pablo Avenue & San Pablo Dam Road; Easy Access to I-80 via San Pablo Dam Road	AC Routes 70-78A-L1	Near Brookside Hospital, Shopping Center, Richmond High School, Residential
HILLTOP MALL/DRIVE	Fair/Good-Could Share Parking With Shopping Center, Structure Needed for Alt. 3 (I-80)	Hilltop Drive and San Pablo Avenue; Good Access to I-80	AC Routes 69-70 70A-78	All Alternatives Except 3 Near Hilltop Mall Shopping Center
SAN PABLO	Use School Site, Otherwise Structure May Be Required	Good via San Pablo Avenue & Rumrill Boulevard; Road 20 Provides Fairly Good Access to I-80	AC Routes 69-70-78	Serves Contra Costa College, Junior High School
PARR BOULEVARD	Excellent	Poor-Difficult Access to I-80	AC Route 78	Low Density/Light Industry Nearby. No Residential Within Walking Distance
ATLAS ROAD	Excellent	Poor-Difficult Access To I-80	AC Route 78	Little Nearby
PINOLE	Good For All Alternatives Except Alternative 3 (I-80) Which Requires Structure	Pinole Valley Road Provides Good Access For I-80 Station, Southern Pacific Alignment Station Is Remote	Q BART Express (Alt. 3) No Service To Other Sites	Near Low Density Housing; Few Jobs In Area
RODEO	Fair-May Require Structure	Good Access to I-80 Via Willow Avenue	AC Route 78	Near Central Rodeo Development Potential To Southwest
CROCKETT	Good-Room For Large Surface Lot	Good Access To I-80 and Carquinez Bridge	No Fixed Service Good Future Inter-modal Transfer Site	Near Central Crockett and Housing
CUMMINGS SKYWAY	Fair-Expensive Earthwork Required	Good Access To I-80 and Cummings Skyway	No Fixed Service	None Now But Future Potential
STATE ROUTE 4	Excellent-Good Temporary Terminal Station	New Street Connections To SR-4 To Be Built; Good Access To Hercules And Rodeo	No Fixed Service	None Now But Future Potential

3. CAPITAL COSTS - FIXED FACILITIES

The development of the capital cost estimates for the fixed facilities for each of the alternative alignments involved several steps. Initially, a set of unit cost factors was developed to express the estimated cost to construct or provide each unit of the physical construction items required for any of the alternatives. These cost factors were carefully adjusted to reflect 1982 cost levels. Separate cost factors were developed to allow an assessment of right-of-way costs. Then the physical construction and right-of-way requirements of each of the 15 alignment alternatives were developed. This analysis established the quantities of each cost item associated with each alternative; for example, the number of feet of trackwork by type, the number of stations by type, and yard and tail track requirements. By applying the unit cost factors to the quantity estimates a cost estimate was generated for each alternative.

The cost estimates and the general review of the alignments as presented in Chapter 2 provided a basis for identifying those alternatives which showed promise for further consideration. These alternatives are identified in the final section of this chapter (see Table 4).

3.1 Unit Cost Assumptions

The unit cost figures used in preparing the BART extension cost estimates are expressed in 1982 dollars, and are listed in Appendix A. Most of the unit cost information was prepared from cost data for previous BART construction contracts or from estimates. This unit cost information was compared with prevailing construction cost figures published in the Engineering News Record and with unit costs obtained from CalTrans. Unit prices involving railroads and trackwork were based on information received from the Southern Pacific Transportation Company.

Where the available data were not current, prices were adjusted to mid-1982 levels by using the revised California Price Index compiled by CalTrans, which is based on 1977 prices having an index value equal to 100.0. The index value used for the current unit costs (except trackwork) was 173.5, which represents the last twelve months average ending with the second quarter of 1982. This eliminates the erratic price fluctuations within the various quarters due to the economic recession of 1981-1982. While most of the construction prices have gone down during the preceding 12 months, track construction and rail-related unit cost items have not changed; consequently, the unit price for trackwork in this estimate is tied to the second quarter of 1981 index value of 187.7. The following illustrates the methodology applied to establish the 1982 unit prices from previous BART construction contract costs which were supplied by BART staff.

Example: Cut-and-cover subway station.

- 1 Structural shell construction cost of \$6.0 million (1970 dollars) was multiplied by a factor of $173.5/45.4 = 3.82$ where 45.4 is the 1970 index value.
- 2 Finish contract cost of \$1.5 million (1971 dollars) was multiplied by a factor of $173.5/50.0 = 3.47$ where 50.0 is the 1971 index value.

While there are several methods for adjusting unit prices to reflect inflation, it was found that the methodology of tying the unit prices to the California Price Index will enable the BART staff to update the estimate for this line extension in any future year by applying the ratio of indices.

The unit cost figures include appropriate allowances for contractor overhead, profit and mobilization/demobilization costs. A 15 percent agency cost for engineering and construction management was added to the construction cost as a common element of all costs. The following is a brief description of the elements included in each item listed in the capital cost estimate:

1. Trackwork. All costs for continuous welded rail, ties, ballast, fasteners, turnouts and their installation.
2. Structures and Civil Work. Costs to construct the transit structures and at-grade trackbed, including related costs such as site preparation, drainage, street relocation and restoration; costs for grade separation structures and retaining walls; costs for the modification of existing grade separations and highway abutments and for railroad relocation.
3. Utility Relocation. Costs to relocate overhead transmission lines or underground utilities, such as cables and pipelines running parallel with BART tracks within the contemplated right-of-way estimated in accordance with site specific requirements.
4. Track Electrification. Costs of the electrical system to furnish power for train propulsion and control, including utility feeder connections, sub-stations (assumed at 1.5 miles average spacing), contact rail, insulators and auxiliary electrical facilities.
5. Train Control - All costs of the automatic train control system, including a train control room and interlock with Lake Merritt Operations Control Center.
6. Communications. All costs for complete train communications systems, including wayside signals and on-board equipment.
7. Stations. Costs for all station construction, including finish work, furnishings and automatic fare collection equipment. Excluded from aerial stations are the BART standard aerial girders supporting the trackwork, which are included in the Structures and Civil Work item.
8. Parking Facilities. Costs of constructing park-and-ride lots or structures and associated kiss-ride and bus transfer areas, including site preparation, drainage, paving, signing, striping, landscaping and lighting. Access roads are included where applicable.
9. Additional Items. Unit prices for additional or specific items were established from documents of authorized sources; including fencing, concrete barriers, landscaping and temporary highway and rail traffic maintenance during construction.

10. Storage Facilities. Costs of storage facilities include all site preparation, drainage, trackwork, paving, fencing, electrification, communication, lighting, and control facility for a yard and tail track. In addition, yard facilities such as office, vehicle service, inspection and cleaning facilities, parking area and service roads are not included. For those alternatives which would extend from the Richmond station through the Richmond yard facility, a cost of \$500,000 for modifications to the yard trackage was included.

3.2 Right-of-Way Costs

The right-of-way of the various alignment segments would occupy publicly and privately owned land of widely differing values. No cost was assumed for publicly owned land required for the BART extension where the requirement was for a minor encroachment onto an existing right-of-way. Market level unit cost values were used for all privately owned land, including residential, commercial and industrial uses. The right-of-way of some of the segments would occupy property which is presently the right-of-way of operating railroads, the availability of which could not be confirmed in this preliminary study.

The unit costs for estimating the right-of-way requirements for each segment of the BART extension alternatives were compiled from available statistical data of recent real estate sales in the study area; from advertised sales literature and from information received from the Southern Pacific Transportation Company in 1981 pertaining to a rough appraisal of a 35 foot wide strip of their mainline right-of-way in Contra Costa County. The unit cost assumed for both the SP and AT&SF railroad rights-of-way is \$2.60 per square foot.

The cost for undeveloped residential land was assumed at \$4.00 per square foot, commercial land unit cost was assumed at \$8.50 per square foot, and industrial land values were assumed

at \$5.20 per square foot. An allowance for the compensation of displaced housing and business is included in the estimate for each segment, where applicable.

Based on recommendation of BART staff, the following unit relocation costs were used as representative values in the capital cost estimates:

Housing Displacement:

- Replacment cost \$100,000
- Moving cost \$ 30,000

Small Business Displacement:

- Replacement Cost \$ 50,000
- Moving Cost \$ 20,000

Wherever only aerial structure columns were located on business property, such as in the case of a trailer storage yard and a nursery, a compensation of \$20,000 was included per column for land and air rights.

The right-of-way and relocation costs for each segment are included in Appendix B.

3.3 Expanded Cost Estimates for Fixed Facilities

Expanded cost estimates for fixed facilities are shown for complete alignments in Table 3, and on a detailed segment-by-segment basis in Appendix B. Total estimated fixed facility costs vary greatly depending upon the alignment selected and the assumptions made relative to design and right-of-way availability. Costs for fixed facilities include trackwork, structural and civil work, utility relocation, electrification, train control, communications, stations, parking facilities, storage facilities, right-of-way, and all related costs. Specifically,

Table 3
COMPARISON OF FIXED FACILITY COSTS FOR EXTENSION ALTERNATIVES
BART WEST CONTRA COSTA EXTENSION STUDY

Alternative	FIXED (1) FACILITY COSTS	LENGTH (2)	COST PER (3) MILE	COMMENTS
1 - Southern Pacific	258.7	13.3	19.5	Requires relocation of four parallel pipelines
2 - AT&SF Railway	254.4	13.6	18.7	AT&SF R/W inadequate, so requires relocation of business and houses.
3 - Inter-State-80	234.6	10.9	21.5	Cost of storage facility high due to 3,000' double track required to reach the yard at SR-4.
4 - San Pablo Avenue	453.9	14.2	32.0	Costly civil and strucure work due to extensive aerial and tunnel sections.
5 - Rumrill/Hilltop/I-80	346.5	10.3	33.6	Requires little private right-of-way.
6 - AT&SF/Hilltop/Southern Pacific	403.8	12.4	32.6	Same as Alternative 4.
7 - AT&SF/Southern Pacific	240.9	12.8	18.8	Cost low because of few aerial structures and at-grade.
8 - Southern Pacific/AT&SF	278.5	14.0	19.9	Second longest alignment, but mostly at grade.
9 - I-80/Southern Pacific	307.3	13.5	22.8	Civil/structural cost high because of long sections along I-80 and retaining wall.
10 - San Pablo Ave/Southern Pacific	434.2	13.5	32.2	Extensive tunnel and aerial sections; storage yard in Hercules.
11 - AT&SF/Hilltop	422.7	13.2	32.0	Extensive tunnel and aerial sections.
12 - AT&SF/Hilltop Southern Pacific	384.5	12.9	29.8	Same as Alternative 11
13 - Hilltop/I-80	165.4	8.0	20.7	Shortest route (uses Richmond yard) terminating at SR-4; assumes I-80 encroachment at no cost and that HOV lanes are not built.
14 - AT&SF/I-80	198.9	11.6	17.1	AT&SF right-of-way costs uncertain; extensive relocation required.
15 - San Pablo Ave/I-80	378.4	11.3	33.5	Civil/structural costs high due to many aerial and tunnel sections. Cost of storage facility high due to 3,000'double track required to yard.

(1) Excludes vehicle costs
(2) In miles
(3) 1982 dollars in millions.

costs for additional BART vehicles are excluded (see Table 24, Chapter 7 for these estimates), and so are operational and maintenance costs of the line (discussed in Chapter 6).

Table 3 shows that the capital cost for fixed facilities range from \$165 million to \$454 million (1982 dollars). Much of the cost differences between lines can be attributed to the length of the extension; although Alternative 13 has the lowest total cost (partly because its terminus at SR-4 makes it the shortest alternative), its \$20.7 million per mile cost is actually somewhat higher than that for Alternatives 1, 2, 7, 8 and 14.

3.4 Identification of the Most Promising Alternatives

With the development of the cost estimates for each of the 15 alternatives and with an understanding of their physical requirements and route characteristics it was possible to identify those alternatives which offered sufficient potential for further consideration.

Seven alternatives were identified as having sufficient merit to warrant further consideration. Each of the alternatives and their key cost-related features are discussed below:

Alternative 1 (Southern Pacific) - The principal advantage of this alternative is that it could be constructed within the Southern Pacific right-of-way. Use of the right-of-way, however, entails certain engineering complexities and costs. This alignment would use a considerable amount of aerial structure in order to avoid interference with rail sidings along the line. There are four parallel pipelines to relocate for this alignment; therefore, utility relocation costs are high.

Alternative 2 (AT&SF Railway) - The existing AT&SF right-of-way cannot entirely accommodate a BART line, so additional right-of-way acquisition and some dislocation of existing structures is required. The right-of-way unit costs are not highly reliable for this alternative.

Alternative 3 (Interstate-80) - This alternative has excellent accessibility from Interstate-80 and from areas close to the freeway interchanges where stations could be provided. The cost for storage facilities is high for this alternative because a 3,000' double tail track is required to reach the yard at SR-4, and this track would drop 45 feet. Right-of-way costs are low because the line stays within the I-80 right-of-way, at the additional cost of higher retaining walls.

Alternative 4 (San Pablo Avenue) - This is the longest and most expensive line (in cost) but it provides direct service to San Pablo and the Hilltop Mall area. Civil and structural costs are particularly high because of the construction of extensive aerial structures, tunnels, and the subway station at Hilltop Mall. A storage yard is required along the SP railroad line in Hercules; use of the Richmond yard presents prohibitive operational problems because this extension would be from El Cerrito Del Norte Station. Right-of-way costs for this alternative are high because relatively little public property would be used.

Alternative 5 (Hilltop Mall and I-80) - Similar to Alternative 4, this alternative involves substantial construction costs to reach Hilltop Mall. However, unlike Alternative 4, a storage yard is not needed; a tail track can be substituted for the storage yard, since the existing Richmond yard would serve this alternative. This results in a significant cost savings.

Alternative 13 (Hilltop Mall and I-80) - This is the shortest extension (8.0 miles); it has only four stations and terminates at SR-4. Desirable features of this alternative are that it serves Hilltop Mall and utilizes mainly public right-of-way. One assumption which will require further resolution concerns the encroachment of the BART right-of-way into the existing I-80 right-of-way earmarked for the High Occupancy Vehicle (HOV) lane widening programmed by CalTrans. The cost estimates assume that this project will not be implemented. If the HOV lane is implemented by CalTrans, then additional costs would be incurred in terms of property acquisition/displacement costs and civil/structural work including retaining walls to create a feasible alignment.

Alternative 14 (AT&SF) Railway and I-80 - Between Richmond and State Route 4 this alignment follows the AT&SF Railway right-of-way as does Alternative 2. Beyond State Route 4, however, this alignment continues north along Interstate-80 to Cummings Skyway. This alternative would have the least cost per mile of any of the 15 options.

3.5 Comparison of Costs with State Route 4 Terminus

A second major consideration that developed during the course of the study was the identification of a logical northern terminus for the alternatives. The alternatives were planned with a northern terminus at either Crockett or Cummings Skyway. The only exception to this was Alternative 13 which would terminate near State Route 4. A suitable northern terminus for the BART extension should provide the following features:

- The last station should serve as an accessible intercept point for travelers on Interstate-80.
- The terminal station should provide adequate accessibility from northern locations of the study area.

- The terminus should have the flexibility of allowing further future extension either to the north along the Interstate-80 corridor, or to the east along the State Route 4 corridor.

Each of the proposed station locations was reviewed in light of these factors. It was concluded that State Route 4 offered a highly suitable northern terminus point since it is quite accessible from both Interstate-80 and the northwest portions of Contra Costa County and would offer flexibility in developing further extensions. The Cummings Skyway Station would also provide good accessibility, but would limit the ease of an eastward extension. The additional 2.8 miles of BART construction from State Route 4 to Cummings Skyway would cost approximately \$51.6 million, over 20 percent of the total extension cost.

Several of the initial fifteen alternatives would not offer a station near the State Route 4/Interstate-80 Interchange. These alternatives would terminate in Crockett. The Crockett terminal offers good accessibility from Interstate-80, but poor flexibility in terms of future extensions to both the north and east. Stations further to the south along the bay-front, such as in Rodeo and Pinole, lack direct access from Interstate-80, but have better extension flexibility. In order to preserve this extension flexibility, it was decided to select the Rodeo Station as the terminal station for Alternative 1 in the "most promising alternatives" analysis. The other six "most promising alternatives" selected for further consideration were assumed to terminate near State Route 4.

Table 4 provides a summary of the comparative capital costs of the seven most promising alternatives terminating near State Route 4/Rodeo.

Table 4

CAPITAL COST SUMMARY - MOST PROMISING ALTERNATIVES - STATE ROUTE 4/RODEO TERMINUS

BART WEST CONTRA COSTA EXTENSION STUDY

NEW CONSTRUCTION

<u>ALTERNATIVES</u>	<u>REVISED TERMINUS</u>	<u>LENGTH (miles)</u>	<u>TOTAL FIXED FACILITY COST (1) (millions \$1982)</u>
1 - Southern Pacific	Rodeo	9.9	\$146
2 - AT&SF Railway	SR-4	8.2	144
3 - Interstate 80	SR-4	8.1	183
4 - San Pablo Avenue	SR-4	8.9	402
5 - Rumrill/Hilltop/I-80	SR-4	7.6	291
13 - Hilltop/I-80	SR-4	8.0	165
14 - AT&SF Railway/I-80	SR-4	8.2	144

1 Fixed Facility Cost only - excludes vehicles.

4. OPERATING PLANS

This chapter covers issues relating to revenue service operation of the proposed line. This includes:

- Development of alternative operating (service) plans for the BART extension;
- Analysis of the line-haul vehicle travel speeds, vehicle travel times, and passenger travel times; and
- Determination of BART line-haul capacities with each operating plan.

The previous chapters indicated that there were seven promising alignment alternatives. In order to provide a more meaningful basis for comparison, each of these alternatives was analyzed here as terminating in the vicinity of the State Route 4/Interstate 80 interchange. Section 4.6 provides a discussion of the operational impacts of extensions beyond State Route 4 (SR-4).

4.1 Operational Strategies

Six operational "strategies" have been examined and are shown in Table 5. They include various types of shuttle and direct services. Each strategy is discussed below in terms of its advantages and potential problems or constraints.

1M Direct SR-4/Daly City Service

Under this strategy, existing Richmond-Daly City trains would be extended to SR-4 (or whatever station is the north-east-most terminus) at 15 minute headways (or possibly shorter headways in the future). This alternative is considered promising because it does not require any increase in transbay tube or Oakland wye capacity, and it provides maximum service to the

Table 5
POTENTIAL SERVICE STRATEGIES
BART WEST CONTRA COSTA EXTENSION STUDY

MOST PROMISING	PLAN #	DESCRIPTION
*	1M	Direct SR-4/Daly City service by extending trains at 15 min. headways.
	2A	Direct SR-4/Fremont service at 15 minute headways.
	2AM	Alternating Daly City & Fremont service, each at 15 minute headways, resulting in 7.5 minute headways between trains.
*	3S	Shuttle trains which couple/uncouple at Richmond or El Cerrito Del Norte. Shuttle service could be along W. Contra Costa line, or between Richmond and El Cerrito Del Norte Station. Service at 15 minute intervals.
	3ST	Shuttle service with across-the-platform (ATP) transfer by passengers.
		Shuttle service could be along W. Contra Costa line, or between Richmond and El Cerrito Del Norte station. Service at 15 minute intervals.
	3SK	Shuttle from SR-4 to MacArthur, with ATP transfer. Service at 15 minute intervals.

riders of the line. Using existing El Cerrito Del Norte patrons as a guide, 82 percent of the extension riders can be expected to travel to San Francisco stations as opposed to Fremont line stations.

2A SR-4/Fremont Service

Direct service to Fremont could be provided either by adding cars to existing trains or by adding new trains (if necessary and after completion of the KE track). The KE track is a third track through downtown Oakland (see Glossary). The transbay tube acts as an indirect constraint since passengers transferring to San Francisco-bound trains would still have to be provided space (seats or standing room) on other transbay trains. The extra inconvenience of transferring would certainly reduce patronage from what it would be under 1M; and, aside from ease of implementation, there are no other clear advantages to this plan over 1M. Weekday service would be provided at 15 minute intervals.

2AM Alternating Daly City and Fremont Service

This operating plan is similar to the one provided on the Richmond line during weekdays. It provides patrons a choice of destinations via direct trains, and provides good local service for within-line travel. The disadvantage of this plan is the additional car miles (and thus cost) generated. Within-line travel (to stations north of MacArthur) is expected to be a relatively small fraction of total ridership. Consequently, the additional cost of this plan is not likely to be warranted by the additional demand created. Trains would run at 15 minute headways for all weekday service.

3S Shuttle Trains with Coupling

New "C" cars will give increased flexibility in adding cars to and cutting cars from an in-service train consist. This plan attempts to exploit this flexibility to reduce the car-miles on the line by running only as many cars as demand on the extension alone warrants. This alternative would also provide 15 minute headways during weekday service.

To successfully use this plan, a four-track station would be necessary at the junction station (Richmond or El Cerrito Del Norte). The major disadvantage of this plan is the time it takes to couple cars--an average of three to four minutes has been utilized in the travel time analysis. Uncoupling trains generally takes a matter of only a few seconds. The new "C" cars can be in the lead, middle, or trailing portion of trains made up of A, B, and C cars.

A variant of this alternative would provide direct service to passengers along the proposed extension, but would utilize shuttle train service between Richmond and El Cerrito Del Norte. This service option would result in a lower quality of service to patrons of the existing Richmond Station compared with present day service, but would also reduce costs by eliminating the need to bring additional cars from or to Richmond to accommodate the passengers who are crossing the platform at El Cerrito Del Norte.

3ST Shuttle With Across-the-Platform (ATP) Transfers

This is a simplified version of 3S, which avoids the operational complexities involved in coupling and uncoupling cars. Instead, a short shuttle train would operate from SR-4 to the junction station (Richmond or El Cerrito Del Norte). Passengers would be required to transfer and wait for the next

train. Such "out of vehicle" travel time is generally considered by patrons to be two or three times as onerous (on a minute-for-minute basis) as "in-vehicle" travel time. Thus, the ATP transfer would have some downward effect on patronage (as discussed in Section 5.4.3).

A variant of this alternative, as with 3S, would provide direct service to passengers along the proposed extension with a shuttle service between Richmond and El Cerrito Del Norte. This would reduce the car-miles which would be involved in this alternative, since it eliminates the need to run additional cars from or to Richmond to accommodate the individuals who are crossing the platform at El Cerrito Del Norte.

3SK SR-4/MacArthur Shuttle

This shuttle would provide more direct service than 3ST, and somewhat faster service than 3S, for those passengers traveling entirely within the Richmond line. Trains would be turned around at MacArthur. Service would be provided at 15 minute intervals during all weekday hours.

Three disadvantages of significant proportions occur with this plan. One is that, particularly during peak hours, MacArthur station is already very busy. Any delay in turning around an SR-4 train could have major systemic impacts. The second disadvantage, from the passenger's viewpoint, is the required across-the-platform transfer at MacArthur Station, since most passengers want to travel to downtown Oakland or San Francisco. Finally, a third disadvantage would occur because there is no yard facility at MacArthur. Extra capacity would be required on the Concord/Daly City line for the patrons to and from the West Contra Costa Extension, which would increase the car-miles and cost to the District over an across-the-plaftorm transfer at

Richmond or El Cerrito Del Norte. The KE track could be used to turn around trains, but this would preclude its use by other trains (such as a Concord-San Francisco express).

4.2 Service Level Assumptions

BART rail service is currently operated between the hours of 6 AM and 12 midnight Monday through Saturday, and 9 AM to 12 midnight on Sundays and holidays. Existing service frequencies on the Richmond line are shown below: (all times in minutes).

	TRAIN DESTINATION	
	DALY CITY	FREMONT
T = Transfer Required		
<u>Weekdays</u>		
Peak Hours	15	15
Mid-Day	15	15
Night	T	20
<u>Saturdays</u>		
Daytime	20	20
Night	T	20
<u>Sundays/Holidays</u>		
All Hours	T	20

Trains on the Richmond-Daly City line, the service of greatest interest to this report, vary from three to eight cars in length, with an average of approximately five cars per train.

In order to provide the necessary capacity on the proposed extension, a minimum of 24 cars per hour would have to be run on the extension in the peak hour/peak direction (using a 27 percent peak hour/direction factor, presently found at El

Cerrito Del Norte). This is shown in Table 6, which is an operating plan for purposes of analysis. Peak hour capacity depends upon service frequency and train length.

Another consideration is that 15 minute headways may not provide adequate capacity to accommodate future Richmond line growth (stations between Richmond and Ashby). This could constrain patronage.

4.3 Travel Time and Average Speeds

Running times for various alternatives have been developed in this study using a detailed section-by-section analysis of dwell, acceleration, cruise, and braking time. This provides a more accurate assessment of running times than would an assumption of a "system average speed," because the run times are affected by grades, and the grades of various alternatives vary considerably from each other and from the existing BART lines.

4.3.1 Car Performance Characteristics

Acceleration characteristics of cars depend most significantly on grades. This analysis accounts for grades using car procurement specifications (nominal acceleration of 1.6 MPH/second with a 0% grade). New C cars are expected to have about the same acceleration characteristics as the existing fleet. Cruise velocity depends on grade, but is nominally 70 MPH (under Performance Level 2) on grades up to one percent. Braking performance currently programmed into the Automatic Train Operation system is:

- 1.6 MPH/sec in tunnels
- 1.2 MPH/sec in all other locations

Normal maximum station dwell time used is 30 seconds, and 15 minutes is assumed as the normal maximum "turn around" time at the end of the line.

Table 6

SERVICE CHARACTERISTICS OF PROPOSED EXTENSION BART WEST CONTRA COSTA EXTENSION STUDY

WEEKDAYS	TRAINS/HOUR	HEADWAYS	CARS / TRAIN	
			Thru Service	Shuttle(1)
7-9AM	4	15	10	6
6-7AM, 9AM-4PM, 6P-12A	4	15	5*	2
4-6PM	4	15	10	6
<u>Saturdays</u> 6A-12A	3	20	4*	2
<u>Sundays</u> 9A-12A	3	20	4*	2

* To be adjusted as total Richmond line demand warrants.

(1) Shuttle service would provide a seat for every passenger, in most cases.

Table 7 shows the line lengths, travel times, and scheduled operating speeds (including dwell time) for the seven most promising alternatives. The average speeds are generally quite high (ranging from 41 to 45 MPH). By way of comparison, the average schedule speed between Orinda and Concord is 33-35 MPH. The high speeds along the proposed extension can be attributed to the long station spacings. Distances between stations on the proposed extension are between 2.2 and 4.2 miles. Average spacing between Orinda and Concord is around 2.7 miles.

Longer interstation spacings allow trains to cruise at 70 MPH for longer periods, thereby increasing the average schedule speed. The speeds shown in Table 7 also assume ideal operating conditions, and as such, are probably best used only for comparison purposes between alternatives. It is important to note that although fewer stations have a favorable impact on line-haul speed, such an arrangement also means that access to the BART system is more limited and is likely to be more auto-oriented. Table 8 shows station-to-station travel times for the various alignments.

4.4 Line-Haul Capacities

Line-haul capacity depends on four factors: the number of seats per car, the policy regarding maximum number of standees, the number of cars per train, and the frequency of trains. Each of these is considered in turn below.

- Seats per Car - A and B cars seat 72 passengers, while C cars will seat 68. 70 passengers have been used for an average capacity in this analysis.
- Standee Policy - BART's Board of Directors has adopted a policy which calls for an equalization of the load factors (total passengers/number of seats) for all lines. As a maximum, 1.5 is used during peak periods, and 1.05 during off-peaks.

Table 7
COMPARISON OF RUNNING TIMES AND AVERAGE SPEEDS TO SR-4
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	DISTANCE (1)	NO. OF STATIONS	RUNNING TIME (mins)	DWELL TIME (mins)	TOTAL (2) (mins)	AVERAGE SPEED (mph)
1 - Southern Pacific	10.4*	4	13.0	1.5	14.5	43
2/14 - AT&SF Railway (3)	8.7*	3	10.6	1.0	11.6	45
3 - Interstate-80	8.1	3	10.6	1.0	11.6	42
4 - San Pablo Avenue	8.9	4	11.6	1.5	13.1	41
5 - Rumrill/Hilltop/I-80	8.1*	4	10.3	1.5	11.8	41
13 - Hilltop/I-80	8.5*	4	11.0	1.5	12.5	41

*Includes 0.5 miles of existing track north of Richmond Station.

(1) Distance from Richmond or El Cerrito Del Norte to SR-4, excluding tail track.

(2) Excludes dwell at junction and SR-4 stations.

(3) Alignments 2 and 14 are identical up to SR-4.

See text for other important assumptions.

Table 8
SCHEDULED RUNNING TIMES FOR ALTERNATIVES*
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE Junction (from) TO	Minutes:Seconds						KEY
	1	2/14	3	4	5	13	
	Richmond	Richmond	EC Del N.	EC Del N.	Richmond	Richmond	
							00:00 Cumulative including station dwell (00:00) Run time from prior station (without dwell)
Parr Blvd.	3:24 (2:54)	N/A	N/A	N/A	N/A	3:24 (2:54)	
Vale Avenue	N/A	N/A	N/A	3:37 (3:07)	N/A	N/A	
San Pablo	N/A	N/A	N/A	N/A	4:27 (3:57)	N/A	
Hilltop Mall/Drive	N/A	N/A	5:25 (4:55)	6:48 (2:41)	6:46 (1:49)	6:43 (2:49)	
Atlas Road	6:31 (2:37)	5:12 (4:42)	N/A	N/A	N/A	N/A	
Pinole	11:27 (4:26)	8:50 (3:08)	9:13 (3:18)	10:23 (3:05)	11:28 (2:12)	11:58 (2:45)	
State Route 4**	N/A	11:34 (2:44)	11:35 (2:22)	13:07 (2:44)	11:49 (2:21)	12:31 (2:33)	
Rodeo**	14:28 (3:01)	N/A	N/A	N/A	N/A	N/A	

N/A = Not applicable to this alternative.

* Using average maximum dwell of 30 seconds per station.

** Station does not include dwell time if it is end of line.

Note: All times exclude dwell time at junction station (El Cerrito Del Norte and Richmond).

- Number of Cars per Train - With train control improvements, train lengths can be between two and ten cars. The shortest combination now operable with A and B cars is three cars (in an ABA configuration).
- Frequency of Trains - Train frequency can be adjusted within constraints dictated by capacity of the Oakland wye and transbay tube.

Based on these assumptions, Figure 5 shows line-haul capacity as a function of train frequency and length. Based on the patronage projections in Chapter 5, a capacity of 1,700 persons per hour in the peak direction would be required. With 15 minute headways, this would require a minimum of four-car trains operating on the line during the peak 60 minutes, which could either be in shuttle-type service, or part of a longer train serving the Richmond line.

4.5 Fleet Requirements

Fleet requirements (i.e. cars) are shown in Table 9. The fleet requirements are based upon the travel times and operating plans discussed in the previous sections. The number of cars required varies with each alternative and depends both on the length of the line (cycle time) and the patronage of the line (see Section 5.4.3).

The car requirements also depend upon whether shuttle or through service is operated. If through service is operated then all trains on the Richmond/Daly City line would have to be increased in length to accommodate the additional passengers on the Extension. This results in more cars being required then for the shuttle alternatives.

All fleet requirements shown in the table include the spare cars typically required for maintenance purposes.

FIGURE 5
FEASIBLE COMBINATIONS OF HEADWAY AND
TRAIN LENGTH TO MEET PASSENGER DEMAND FOR A
RATIO OF TOTAL TO SEATED PASSENGERS OF 1.5
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY

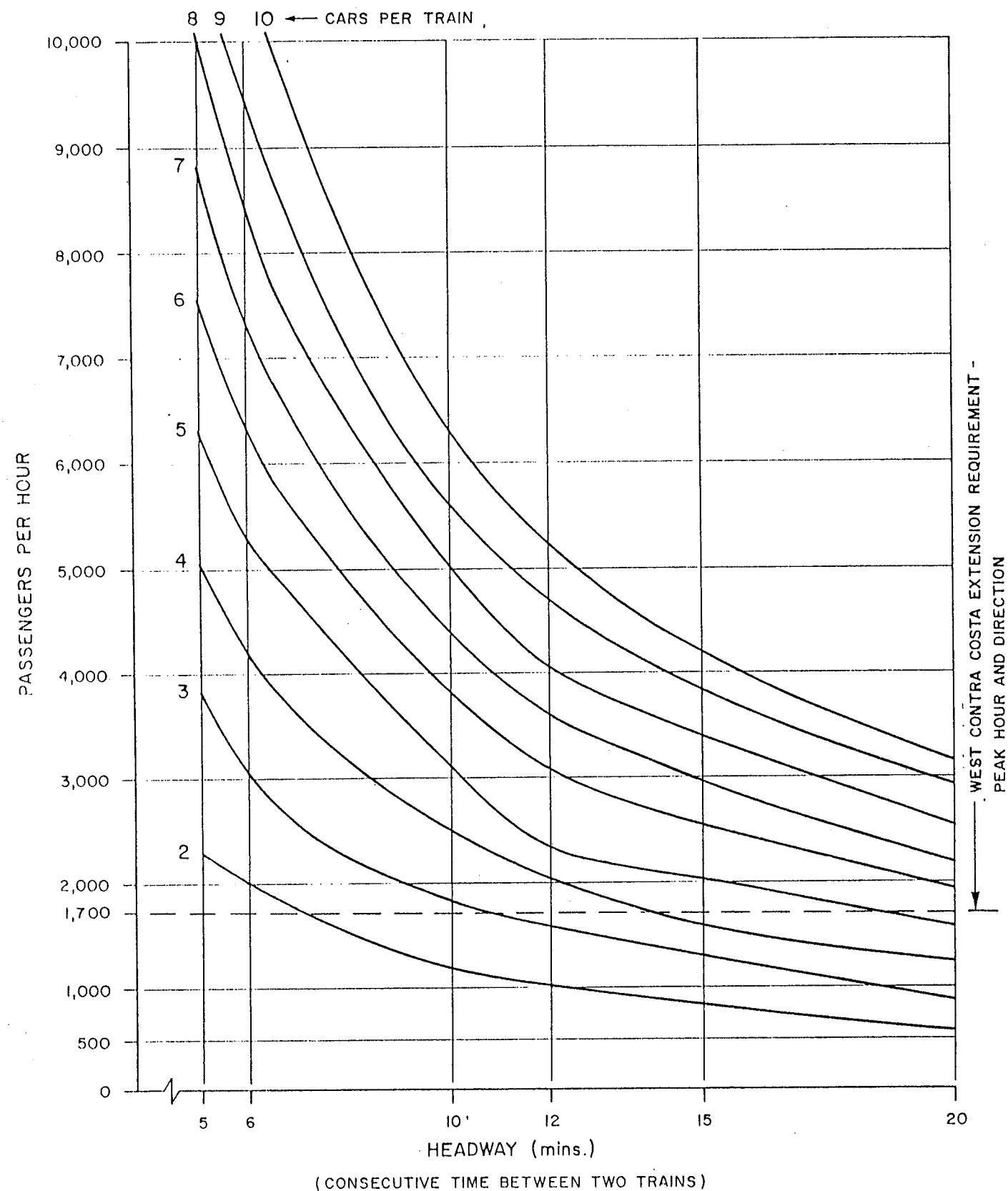


Table 9
FLEET REQUIREMENTS FOR EXTENSION ALTERNATIVES TO SR-4
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	CARS REQUIRED SERVICE	
	Thru	Shuttle
1 Southern Pacific ⁽¹⁾	24	24
2 AT&SF Railway ⁽²⁾	27	25
3 Interstate-80	33	28
4 San Pablo Avenue	39	30
5 Rumrill/Hilltop/I-80/SR-4	38	30
13 Hilltop/I-80	32	27
14 AT&SF/I-80	27	25

(1) Alignment #1's terminus near SR-4 is assumed at Rodeo. There is no SR-4 station for this alignment.

(2) Identical to Alignment #14 up to SR-4.

Note: Car requirements include 15 percent spares.

4.6 Extensions Beyond State Route 4

There are two basic route alignments that could take the West Contra Costa extension beyond a terminus at State Route 4 (SR-4). The shortest route would follow the Interstate-80 freeway to a terminus about one mile south of Crockett, near Cummings Skyway interchange. The other route would follow the shoreline/Southern Pacific right-of-way to a terminus near downtown Crockett. Alternatives 1, 2, and 4 would utilize the SP alignment, while Alternatives 3, 5, 13, and 14 would utilize the I-80 alignment.

The operational strategies and service levels presented in Sections 4.1 and 4.2 are equally applicable to an alternative ending at SR-4 as they are to one terminating near Crockett, so no additional discussion of them is provided here. The travel time needed to reach the Crockett area from SR-4 amounts to between 4.0 and 4.5 minutes depending on whether the I-80 or Southern Pacific alignment is used.

The additional travel time involved in reaching Crockett from State Route 4 has implications so far as the operating costs and fleet requirements are concerned. The additional operating costs created by running to Crockett are discussed in Section 6.2. The total cars required for through service beyond SR-4 are shown in Table 10. A total of between 30 and 47 cars are required to provide Crockett service with the same operating plan as used in discussing the other alternatives.

Table 10
FLEET REQUIREMENTS FOR THROUGH SERVICE BEYOND SR-4
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	NORTHERN TERMINUS	CARS REQUIRED-THRU SERVICE	
		INCREMENTAL	TOTAL
1 - Southern Pacific	Crockett	6*	30
2 - AT&SF Railway	Crockett	8	35
3 - Interstate-80	Cummings	8	41
4 - San Pablo Avenue	Crockett	8	47
5 - Rumrill/Hilltop/I-80	Cummings	8	46
13 - Hilltop/I-80	SR-4	N/A	N/A
14 - AT&SF Railway	Cummings	8	35

N/A = Not applicable to this alignment
Car requirements include 15 percent spares.

*Lower car requirement because of shorter distance between Rodeo and Crockett (this alternative ends near Rodeo, not SR-4).

5. PATRONAGE ANALYSIS

The patronage assessment of a BART extension into the West Contra Costa County study area focused on the potential for growth of the study area in terms of population and employment. Other key factors which would affect patronage are the quality and accessibility of the proposed BART service.

5.1 West Contra Costa Corridor Characteristics

According to estimates by the Association of Bay Area Governments (ABAG), the West Contra Costa corridor had a population of approximately 145,000 in 1980. In the corridor, Richmond contains the densest concentration of residents and, to an even greater extent, employment. There is also considerable commuting from the communities north of Richmond to Oakland and San Francisco. These communities--San Pablo, Pinole, Hercules, Rodeo, and Crockett--are principally suburban in nature and rely on other communities for most of their employment.

The northern communities contain a considerable amount of developable open space. ABAG is currently preparing revised forecasts of future land use, population, and employment in these communities, however, only older information based on Projections-79 (1979) is available for this study. In particular, the employment forecasts in Projections-83 are expected to be substantially different. The data from the 1979 projections are shown in Table 11.

There are a number of major activity centers which are major attractors of trips in the corridor. These include Hilltop Mall Shopping Center, Brookside Hospital and Contra Costa College. In the future, the City of Hercules is planning some industrial development in the Refugio Valley (I-80/SR-4 vicinity) which could be a significant employment center in the area.

Table 11

COMPARISON OF 1980 AND 1995 POPULATION/EMPLOYMENT IN WEST CONTRA COSTA COMMUNITIES
BART WEST CONTRA COSTA COUNTY EXTENSION STUDY

AREA	1980		1995		% POPULATION GROWTH	
	TOTAL POPULATION	TOTAL EMPLOYMENT	TOTAL POPULATION	TOTAL EMPLOYMENT	ANNUAL	CUMULATIVE
Hercules	7,300	1,102	22,190	1,449	7.7	204
Pinole	27,050	3,096	29,772	3,833	0.6	10
Richmond	82,650	36,129	85,634	42,342	0.2	4
Rodeo/Crockett	8,858	4,360	13,000	5,204	2.6	47
San Pablo	19,400	5,582	24,063	7,479	1.4	24
TOTAL	145,258	50,269	174,659	60,307	1.2	20

SOURCE: Association of Bay Area Governments, Projections-79.

These figures are under revision by ABAG, and new projections will be available later in 1983.

Based on extrapolation of existing development trends, most of the future development in the corridor is likely to be of a relatively low-density residential nature, with some medium density residential and light industrial facilities clustering near the major transportation arteries. One objective of the extension would be to focus some of this development around the BART stations.

The West Contra Costa area is expected to grow somewhat faster than the rest of the Bay Area, with a population growth rate averaging 1.2 percent per year between 1980-95 versus one percent per year for the tri-county BART District. The only areas with "high" growth rates (above two percent per year) are Rodeo and Hercules. Even though Projections-79 population estimates are probably low (relative to the 1980 Census), the absolute gain in the population between now and 1995 is likely to be under 40,000 persons. While employment in Contra Costa County is expected to grow dramatically in the next few decades, most developer interest seems to be in the central county and the San Ramon Valley. There is little evidence to suggest that West Contra Costa (north of Richmond) would provide enough employment to be a major trip attractor for "reverse commute" trips, although there certainly will be increases in employment, such as in the Refugio Valley.

The principal highway routes in the area include Interstate-80, San Pablo Avenue (State Route 123), and State Route 4. Transit systems are discussed in the following section (5.2). The proposed BART extension would generally parallel I-80. I-80 is currently a six lane freeway which becomes heavily congested during commute hours. CalTrans hopes to increase capacity here by constructing a carpool (high occupancy vehicle lane) along the west side of I-80 in this area.

5.2 Existing Transit Systems and Ridership

BART rail service currently serves the southern edge of the study area with its Richmond and El Cerrito Del Norte Stations. These stations currently serve about 4,600 and 8,200 one-way passenger trips on an average weekday, respectively. Total system ridership is about 185,000 one-way passenger trips. Many residents of the West Contra Costa area use BART by driving or taking buses to the Richmond or El Cerrito Del Norte Stations. These stations also indirectly serve residents of Napa and Solano Counties.

Existing fixed route bus transit service in the corridor is provided by AC Transit and the Western Contra Costa County Transit Authority (WCCCTA).⁽¹⁾ AC Transit service is concentrated in the Richmond area, with two exceptions. A route 78A bus travels all the way to Crockett on San Pablo Avenue, and the "Q" BART Express bus, which is operated under contract to BART, feeds the El Cerrito Del Norte Station. WCCCTA also operates dial-a-ride service. Generally, transit service can be characterized as sparse and oriented towards commuters (in AC Transit's case) and students (WCCCTA service).

Local transit service in the current WCCCTA service area was virtually non-existent until 1976, when BART began operating an express bus service between Pinole and El Cerrito Del Norte BART Station. This operation provides transit service to an area that was not directly served by BART, but which contributed to BART's construction and operations through county-wide taxes.

(1) Some of this material was adapted from "Western Contra Costa County Transit Authority Short-Range Transit Plan", JHK & Associates, August, 1981.

At the same time, local support had been developing for initiating more local transit service; and this movement culminated in the formation of the Western Contra Costa County Transit Authority in August, 1977. The WCCCTA was the result of a Joint Exercise of Powers Agreement between Contra Costa County and the Cities of Pinole and Hercules. The WCCCTA was empowered to own, operate, and maintain public transit services in the area extending from Montalvin Manor in the south to Port Costa in the north. This area is immediately north of Richmond, which is the northernmost part of the Alameda-Contra Costa County Transit District (AC Transit) and which is well served by AC Transit services.

Initial transit planning for the area was conducted by the Metropolitan Transportation Commission and Contra Costa County. Three fixed routes (404, 405, and 406) were established and operated under a contract between WCCCTA and Vaca Valley Bus Lines, Incorporated, beginning September 5, 1978. In addition, WCCCTA contracted with AC Transit to extend Route 78A north to Crockett. There was considerable duplication of service, but together, they provided excellent coverage of the service area.

All of these routes operated at headways between 45 minutes and an hour, except for the BART Express route during the peak period, which had 30-minute headways. The BART line had a base fare of 25¢ (10¢ for children, elderly and handicapped); the other routes charged 35¢ (25¢ for students, 10¢ for elderly and handicapped).

Routes 78A and Q continue to operate today. The three routes operated by Vaca Valley Bus Lines were terminated after one year. During this brief period, ridership on the three routes reached about 1,500 persons per day, and over 80 percent of these riders were students going to and from school. Ridership during July and August 1979--the last two months of service--dropped off sharply as fewer students rode.

5.3 Travel Time Comparisons

Table 12 shows a comparison of two typical trips made by transit from Hilltop Mall and from SR-4 to Montgomery Station in San Francisco. The table shows that there would be a time savings of 10 minutes over the existing bus-access trip from Hilltop Mall (i.e., bus from Hilltop Mall to BART El Cerrito Del Norte Station and then BART to Montgomery Station), and a 20 minute savings for a trip from SR-4.

5.4 Estimated 1995 Patronage for Alternative Alignments

5.4.1 Patronage Estimation Methodology

In order to develop meaningful comparisons between alternative alignments, as well as between different extension alternatives in the tri-county BART area, patronage projections were developed. It is especially important that the differences between alternatives are highlighted and analyzed as they affect the physically different alternatives. The patronage forecasts also become input to the subsequent cost analyses and financial assessments, since they provide the basis for estimating fare revenue. As noted in the prior section, they also serve an important role in the development of the service/operating policies.

Four patronage estimation techniques have been selected for use here. While they are not the only ones available, they are the ones most appropriate to a study of this type.

- "Similar Stations" Model - With this model, existing BART stations' patronage is used to develop patronage forecasts for the proposed West Contra Costa Stations.
- "Percent of I-80 Traffic" Model - This technique uses peak hour and all-day traffic volumes on the principal regional highway (I-80) and a forecast modal diversion to BART to estimate peak and all day patronage.

Table 12
COMPARISON OF TRANSIT TRAVEL TIMES
CURRENT AND WITH EXTENSION, TO MONTGOMERY STATION
(Times in Minutes)
BART WEST CONTRA COSTA EXTENSION STUDY

TRIP SEGMENT	FROM HILLTOP MALL		FROM STATE ROUTE 4	
	Current	w/Extension	Current	w/Extension
Walk to Stop/Station	5	5	5	5
Wait for Bus	5	-	5	-
*Bus In-Vehicle Time	10	-	26	-
Transfer to BART	2	-	2	-
Wait for Daly City Train	8	8	8	8
**BART In-Vehicle Time to Montgomery	35	42	35	48
Walk to Destination	5	5	5	5
TOTALS	70	60	86	66

*Time from public timetable for J Bus (from Hilltop) and Q bus (from State Route 4 park-and-ride lot).

**From "BART Weekday Train Schedules," dated April 1983.

- "Build-Out of Station Area" Model - This model assumes a "build out" of the immediate area surrounding the proposed stations, and uses generalized land uses, trip generation rates, and modal diversion percentages to allocate trips to BART.
- "Service Elasticity (Pivot Point)" Model - Patronage on the existing BART Express Bus lines is used in this technique to provide a "pivot point" for the analysis. The percent change in travel times and service frequency (waiting time) are used to "pivot" this existing patronage into a patronage estimate if the extension were built today. A growth factor is then applied to develop future-year projections of patronage, based on population and other growth in the area.

It should be stressed from the outset that these techniques provide "order of magnitude" estimates of the proposed line's patronage. However, using more than one technique provides a useful cross-check on the others--a kind of "patronage triangulation" which permits evaluation of the reasonableness of the estimates. The time frame chosen for the future patronage is the period 1995-2000, when the line might reasonably be expected to be complete.

5.4.2 Comparison of Forecast Results

The four techniques above provide somewhat disparate results so far as a single patronage number is concerned. A good mid-range estimate would be 5,500 - 7,200 new one-way passenger-trips per day (line E, Table 13). This represents the upper-end of the percentage of I-80 traffic estimate, and the lower end of the "similar stations" method (see Table 13), and it assumes the service frequencies shown in Table 6 (15 minute peak headways). The station area "build out" technique must be discounted to a large extent because it assumes intensive development around stations, without respect to prevailing market focuses. For service operational planning, 6,300 passenger-trip productions (i.e., round-trips) per day have been used.

Table 13

COMPARATIVE BASELINE TRAVEL FORECASTS FOR WEST CONTRA COSTA EXTENSION⁽¹⁾
BART WEST CONTRA COSTA EXTENSION

	<u>Low</u>	<u>High</u>
(A) Range of estimates of passenger trip productions (round-trips): low end is from pivot-point technique; high end from station build-out technique.	3,000	16,000
(B) Mid-range estimate (i.e. most likely) of (A) above, in trip productions per day	5,400	7,100
(C) Multiply by two to get total weekday one-way trips (productions and attractions)	10,800	14,200
(D) Subtract trips foregone if extension is built only to State Route 4 (minus 800 to 1,200 trips)	10,000	13,000
(E) Multiply (D) by 0.55, to get newly attracted trips (those which wouldn't be made without the extension)	5,500	7,200
(F) Multiply (D) by .5 and by 27%, to get peak sixty minute/peak direction passenger demand	1,350	1,750

(1) For average weekday in 1995. Includes full extension to Crockett, except where noted, and assumed headways shown in Table 6: 15 minute headways all day during weekdays.

The existing Richmond Station ridership by way of comparison, is 2,300 passengers (round-trips) per day. The El Cerrito Del Norte Station serves 4,100 passengers per day (compare to lines A and B of Table 13).

5.4.3 Patronage Forecasts for Alternative Alignments

Ridership projections for the various route alternatives are shown in Table 14.

These results agree with intuition, in that the alignments most central to existing and proposed population centers (Alternatives 3, 4, and 5) have the greatest ridership; routes also differ in ridership due to the number of stations provided along each line.

The impact of utilizing a shuttle service with across-the-platform transfers at Richmond or El Cerrito Del Norte would have the impact of lowering these estimates by approximately 22 percent.

Ridership along the proposed alignment would come from two sources: those who would use BART only because of the extension (i.e., those who switch modes), and those who would ride BART anyway (by either driving or taking transit to El Cerrito Del Norte or Richmond Stations). Based on past estimates of latent BART ridership, and estimates from the Warm Springs BART Extension Study, somewhere between 50 and 60 percent of the ridership on the line (5,500 - 7,200 one-way passenger trips/day) would be "new riders"--travelers who would switch from other modes of travel.

Table 14

1995 FORECAST OF RIDERSHIP BY ROUTE ALIGNMENT
BART WEST CONTRA COSTA EXTENSION STUDY

ALIGNMENT	GROSS DAILY ONE-WAY PASSENGER TRIPS
1 - Southern Pacific	5,200 - 8,200
2 - AT&SF Railway	6,400 - 9,800
3 - Interstate-80	8,400 - 13,200
4 - San Pablo Avenue	10,000 - 16,000
5 - Rumrill/Hilltop/I-80	10,000 - 15,600
13 - Hilltop/I-80	7,800 - 12,400
14 - AT & SF/I-80	6,400 - 9,800

Note: For trip productions (round trips), divide the above forecasts by two. Assumes extension to State Route 4, with half of all patrons who would have used a Crockett area station (400 - 600 trips per day) now assumed to use SR-4 station.

5.4.4 Patronage Forecasts for Individual Stations

An important, albeit difficult, task in the patronage forecasting process is to develop disaggregated projections of 1995 line and station volumes. The approach used in this effort was to try to use all available information sources which might bear upon the individual station's ridership: peak freeway on-ramp volumes nearest the proposed station location, community population, and other descriptors of activity levels (such as enrollment, in the case of Contra Costa College, or square feet of retail space for Hilltop Mall). In the case of a community having more than one station location, a community "centroid" was estimated, and pivot-point travel modeling techniques were used to determine what impacts movement of a station away from this centroid would have in terms of patronage.

Table 15 shows the individual station volumes (in passenger trip productions per day) as they have been forecast by this report. The analysis uses 10,000 - 13,000 one-way trips per day as the baseline for the highest-ridership alternatives, and allocates patrons from this total. Stations having the highest ridership include Vale Avenue, Hilltop Mall, San Pablo, and State Route 4.

These projections are subject to a number of caveats, the most significant of which is the assumption regarding the local land development patterns in the vicinity of stations. Different growth rates in Napa and Solano Counties would also effect ridership at the terminal station (Crockett, Cummings Skyway, or SR-4).

5.5.5 Station Access Needs

Most of the proposed passenger stations are expected to be primarily reached by automobile. This is because, in most

Table 15

1995 STATION PATRONAGE FORECAST⁽¹⁾
BART WEST CONTRA COSTA COUNTY EXTENSION STUDY

STATION	PATRONAGE (2)	COMMENTS
Vale Avenue	800-1,300	Near Brookside Hospital and developed portions of North Richmond
Hilltop Mall	1,100-1,800	Shopping Center with 550,000 square feet of retail space; housing to east
San Pablo	1,100-1,600	Near Contra Costa College (1982 enrollment 9,000, plus 400 staff); nearby residential development in N. Richmond
Parr Boulevard	700-1,100	Fairly isolated; mostly auto access
Atlas Road	400 - 500	Very isolated; mostly auto access
Pinole	800-1,200	Nearby residential
State Route 4	1,700-2,600	Intercepts many trips from east along SR-4; also serves Rodeo; good access from I-80
Rodeo	400 - 700	Relatively little population served by this station, some employment planned nearby
Crockett	700-1,100	Relatively little population served by station; mostly intercepts trips from Solano County
Cummings Skyway	700-1,100	See comment above for Crockett

(1) Based on mid-range estimates of patronage (Average Weekday Trip Productions).

(2) Passenger trip productions (round-trip). See Table 6 for headway assumptions.

NOTE: Patronage figures are not strictly additive because of variations in station locations and line lengths (travel times).

cases, the area around stations is presently low density development (or undeveloped), there is high auto ownership among households, and relatively little transit service exists. Future changes in this situation--higher density development near stations or improved transit service--may alter this situation. However, for planning purposes here, it was generally assumed that the "worst case" situation would involve predominantly auto-oriented access to stations.

Evidence which further reinforces this conclusion is the nature of the proposed station service areas, which is primarily that of a trip-producing suburban area. Shopping and employment sites typically are trip-attracting areas which rely heavily upon walk and transit egress modes because of the lack of a car being available at the destination-end of the trip.

The existing access modal splits at Richmond and El Cerrito Del Norte Stations have been used as a guideline for predicting West Contra Costa station modal splits. They are shown in Table 16.

In order to assess the future parking requirements and access needs of potential stations, the ten candidate station groups have been sorted into three categories, according to type of access. They are the stations that would be auto-dominated, those that would be non-auto-dominated (i.e., high walk and transit usage), and "hybrid" stations which fit into neither category. The forecast access mode splits and classification of stations are shown in Table 17 on the following page. The table shows that five of the stations would be auto-dominated, four would be hybrid, and one station (Vale Avenue near El Cerrito Del Norte) would be non-auto-dominated. Estimated station parking requirements are shown in Appendix C.

Table 16
EXISTING (MAY 1982) ACCESS MODAL SPLITS
BART WEST CONTRA COSTA EXTENSION STUDY

<u>TRAVEL MODE</u>	<u>RICHMOND</u>	<u>EL CERRITO DEL NORTE</u>
Auto Alone and Shared (2 persons)	35%	51%
Carpool (3 or more persons)	2	3
Kiss/Ride (Drop off)	10	10
Transit	19	14
Walk or Bicycle	34	22

Table 17
STATION ACCESS CHARACTERISTICS
BART WEST CONTRA COSTA EXTENSION STUDY

<u>TRAVEL MODE</u>	<u>PERCENT OF PASSENGER ACCESS TRIPS BY STATION TYPE</u>		
	<u>Auto-Dominated</u>	<u>Station Type Hybrid</u>	<u>Non-Auto-Dominated</u>
Auto Alone	55%	35%	25%
Shared Ride (2+) *	15	10	10
Kiss/Ride	10	15	10
Transit	5	15	25
Walk/Bicycle	15	25	30

<u>Stations</u>			
	Parr Boulevard	Hilltop	Vale Avenue
	Atlas Road	San Pablo	
	Pinole	Rodeo	
	Cummings Skwy.	Crockett	
	SR-4		

* Assumes average vehicle occupancy is 2.3 persons.

6. OPERATING COSTS AND FARE REVENUE

The operating and maintenance costs of the proposed extension are based upon the service levels described in Chapter 4 and unit cost assumptions obtained from various departments within BART. The service levels have been designed to match the forecast demand on the line in 1995. They involve 15 minute headways during weekday peak and off-peak hours, and 20 minute headways on Saturdays, Sundays, and holidays.

6.1 Basic Assumptions

6.1.1 Unit Operating Costs

The unit costs of BART service are divided into four expense components:

- Power
- Vehicle Maintenance
- Transportation
- Administrative and Overhead

Power costs include the costs for electricity used to propel trains, run train auxiliaries (air conditioning, etc.), and service passenger stations. Maintenance costs include BART's estimated cost of maintaining cars, including repairs and preventive maintenance. Both of these costs are based on current BART per-vehicle-mile unit cost experience.

Transportation costs include the wages, fringe benefits, employer taxes, and shift/overtime premiums of staff employed directly to serve the extension. This includes station agents, additional train operators, and supervisory personnel for

station agents and train operators. Unit transportation costs have been developed on a per-person basis.

Administrative and overhead costs include general support, administration of right-of-way, plant maintenance, fare collection operation and maintenance costs, and police services. While BART has not developed an incremental cost function for overhead, a reasonable estimate is 15 percent of the total of all other costs.

The unit cost estimates applied are shown in Table 18.

6.1.2 Fare Policy

Current BART rail fares are computed using a formula incorporating a basic charge (60 cents) plus a distance charge, plus special surcharges (e.g. for transbay and Daly City trips). Adult express bus fares are 60 or 90 cents, depending upon whether one or two zones are traversed, respectively.

Because the per-mile charge drops with increasing trip length, the incremental fare revenue generated by the West Contra Costa Extension will depend upon the average trip length. The average trip length for passengers originating from extension stations has been estimated at 20 miles, which is approximately the distance from Pinole Station to Montgomery Station.⁽¹⁾

An average fare generated by the extension of 79 cents per passenger trip has been used here. This average fare also includes the fare concessions currently granted to elderly and youth riders.

⁽¹⁾The average rail trip length from El Cerrito Del Norte Station is 13.5 miles.

Table 18
OPERATING AND MAINTENANCE UNIT COST ASSUMPTIONS
BART WEST CONTRA COSTA EXTENSION STUDY

	<u>COST (1982 \$)</u>	<u>UNITS</u>
(P) POWER	\$ 0.61	vehicle-mile
(VM) VEHICLE MAINTENANCE	\$ 0.66	vehicle-mile
(TL) TRANSPORTATION LABOR		
Train Operators	\$ 35,800	operator
Station Agents	\$ 35,800	agent
Supervisor/foreworker*	\$ 46,000	supervisor
(OH) OVERHEAD AND ADMINISTRATION		
OH = 0.15 X (P+VM+TL)		

*One supervisor is required for every 6.9 train operators and station agents.

A 25 percent back-up requirement is needed for train operators. One train operator is required per train. Three station agents are required per station day (i.e. three shifts per day, 21 shifts per seven day week).

The average trip length on the extension itself is expected to be about six miles. All fares (as well as costs) in this report are in 1982 dollars and would be adjusted for inflation in the future.

6.2 Operating Cost Analysis

6.2.1 Service to State Route 4

Operating costs for various alignments and service operations were developed using the assumptions above. All costs are shown assuming service to State Route 4 area⁽¹⁾, in order to maintain comparability among alternative alignments. Extensions beyond SR-4 are discussed in Section 6.2.2. The operating costs include the costs of operating the extension itself plus those of increasing the capacity of existing service on the Richmond-Daly City line to accommodate passengers newly attracted by the extension.

Table 19 shows the results of the operating cost analysis (operating cost, as used here, includes power, transportation and vehicle maintenance costs). There are two important implications to the table. One is that substantial cost savings (of about 30 percent) could be achieved by using shuttle service rather than through service. This is a result of fewer car-miles being generated by the shuttle alternative, particularly during peak hours. During peak hours, 10 car trains would operate on the line, even though only four car trains would be required.

The second implication is that a substantial difference exists between the operating costs of the alignments, with a difference of almost \$1 million per year between the least and

⁽¹⁾Since the Southern Pacific Alignment (#1) does not have an SR-4 station, Rodeo is used as the terminus.

Table 19

COMPARISON OF ANNUAL OPERATING COSTS
FOR ALIGNMENT AND SERVICE OPTIONS TO SR-4
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	LENGTH	AVERAGE SPEED ⁽²⁾	ANNUAL OPERATING COSTS (In 1982 \$ millions)			TOTALS	
			THRU SERVICE	SHUTTLE SERVICE	EXISTING SYSTEM ⁽³⁾	THRU SERVICE	SHUTTLE SERVICE
1 - Southern Pacific ⁽¹⁾	10.4*	43 MPH	\$4.7	\$2.7	\$2.2	\$6.9	\$4.9
2/14 - AT&SF Railway	8.7*	45 MPH	4.6	2.5	2.2	6.8	4.7
3 - Interstate-80	8.1	42 MPH	4.0	2.4	2.2	6.2	4.6
4 - San Pablo Avenue	8.9	41 MPH	4.9	2.7	2.2	7.1	4.9
5 - Rumrill/Hilltop/I-80	8.1*	41 MPH	4.5	2.7	2.2	6.7	4.9
13 - Hilltop/I-80	8.5*	41 MPH	4.7	2.7	2.2	6.9	4.9

*Includes 0.5 miles of existing track north of Richmond Station.

(1) Terminates at Rodeo.

(2) Includes station stops.

(3) Cost of additional service on Richmond-Daly City line for newly attracted trips.

the most costly alternatives. This variation is attributable to differences in average speed and length between alternatives. Alternative 1, for example, has an average speed of 43 MPH and a length of 10.4 miles to the State Route 4 vicinity (Rodeo). Alternative 3, by comparison, has an average speed of 42 MPH and a length of only 8.1 miles to SR-4.

Current operating costs of BART Express Bus services in the corridor are approximately \$0.9 million per year. This service would be eliminated (at least south of SR-4) as a result of a BART rail extension in the West Contra Costa corridor. The net operating costs would thus be somewhat less than that shown in Table 19. The operating cost per trip was developed by annualizing the average weekday patronage, and then dividing by the total operating costs shown in Table 19. The annualization factor, based on the existing relationship between weekday and annual ridership at El Cerrito Del Norte Station, was 287.

6.2.2 Extensions Beyond State Route 4

The incremental operating cost for service north of SR-4 to the Crockett area (in addition to that shown in Table 19) is shown in Table 20. The analysis shows that the I-80 route would have somewhat less incremental operating cost than the Southern Pacific alignment. Incremental extension service costs for a shuttle operation to Richmond or El Cerrito Del Norte Station would almost halve the costs of the service compared to running through trains.

6.3 Fare Revenue

6.3.1 Service to SR-4

Gross fare revenue projections have been made on the basis of patronage projections contained in Chapter 5. These projections make allowances for differences in patronage for each

Table 20
COSTS OF THRU CROCKETT SERVICE
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	ANNUAL OPERATING COST (in 1982 \$ millions)			
	THRU SERVICE		SHUTTLE SERVICE	
	INCREMENTAL	TOTAL	INCREMENTAL	TOTAL
1 - Southern Pacific	\$1.6	\$8.5	\$0.9	\$5.8
2 - AT&SF Railway	2.4	9.2	1.3	6.0
3 - Interstate-80	1.4	7.6	0.8	5.4
4 - San Pablo Avenue	2.4	9.5	1.3	6.2
5 - Rumrill/Hilltop	1.4	8.1	0.8	5.7
13 - Hilltop/I-80	N/A	N/A	N/A	N/A
14 - AT&SF Railway	1.4	8.2	0.8	5.5

NOTE: All costs include additional service on Richmond-Daly City line to accommodate newly-attracted trips.

N/A = Not applicable to this alternative.

alternative alignment, along with the reduction in patronage which would result from requiring across-the-platform transfer of passengers in a shuttle-type service. The forecast annual fare receipts are shown in Table 21.

This table is labeled "gross fare revenue" because it includes fares from two types of passengers: those who are attracted to BART solely because of the West Contra Costa Extension, and those who would have ridden BART anyway, using the El Cerrito Del Norte or Richmond Stations. The revenue estimates are based on the incremental revenue for trips on the extension which would be part of longer trips beyond the extension.

The new fare revenue was calculated as follows: fare revenue would come both from existing passengers (passengers who would use BART in the absence of the extension) and from newly-attracted passengers. For the old passengers, the net fare revenue would be the additional rail fare obtained from the portion of the trip north of Richmond or El Cerrito Del Norte. For an average trip of six miles, and fare charge of 2.4 cents per mile (based on BART's current "fare taper"), this equals about 14 cents. For new trips, the entire fare charge is credited to the extension. The average fare, based on the 14 mile current average rail trip length from El Cerrito Del Norte, plus six miles on the extension, is expected to be \$1.50. Based on a weighted average of the two groups, and assuming half the riders are new riders and half old, the revenue per passenger would be 90 cents. This (adult) fare needs to be adjusted by a factor of 0.88 to reflect fare discounts to youth and elderly riders. Therefore, the average fare revenue generated would be 79 cents.

Offsetting the fare revenue would be a loss of somewhat over \$0.1 million per year which represents fares collected on BART Express Buses in the corridor.

The important conclusion from the table is that the shuttle service results in lower fare revenue because it is less attractive due to the transfer required at the junction station.

Table 21
GROSS FARE REVENUES FROM VARIOUS ALIGNMENTS (ANNUAL)
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	FARE REVENUE (1982 \$ millions)			
	THRU SERVICE		SHUTTLE SERVICE	
	Low	High	Low	High
1 - Southern Pacific	\$1.2	\$1.9	0.9	1.5
2 - AT&SF Railway	1.5	2.2	1.2	1.7
3 - Interstate-80	1.9	3.0	1.5	2.3
4 - San Pablo Avenue	2.3	3.6	1.8	2.8
5 - Rumrill/Hilltop/I-80	2.3	3.5	1.8	2.7
13 - Hilltop/I-80	1.8	2.8	1.4	2.2
14 - AT&SF Railway	1.5	2.2	1.2	1.7

NOTES: All alternative shown end near State Route 4.
Calculations assume a 79 cent average incremental fare, which includes adjustments for special senior and youth fares.

However, this reduction (22 percent) is more than offset by the reduction in operating costs shown in Table 19.

6.3.2 Extensions Beyond SR-4

The incremental fare revenue attributable to an extension beyond SR-4 would be modest. Many passengers from Rodeo, Crockett, and Napa and Solano Counties would utilize BART by travelling first to the SR-4 station. It is likely that only 800-1,200 additional one-way passenger trips would occur due to the Crockett extension, which would result in additional annual fare revenue of \$180,000 - \$270,000. As was shown in Table 20, the incremental costs of operating the Crockett service are many times greater than this.

While the incremental patronage estimates stated for the Crockett extension are low, there is always the possibility that future development in the area could substantially increase patronage. In that case, the Crockett extension would be more justified. In any case, the option to extend beyond SR-4 has been kept open throughout the study.

6.4 Farebox Recovery

6.4.1 Extensions to SR-4

The farebox recovery ratio represents the percentage of operating costs covered by passenger fares. The analysis performed for various alignment and service alternatives is shown in Table 22. The analysis shows that the extension would probably have a lower farebox recovery ratio than the existing BART rail system. BART Planning and Analysis Department staff project a farebox recovery ratio of between 53 and 56 percent in 1990 for the basic system. The current (FY 1983) farebox recovery is about 45 percent.

The estimated farebox recovery for the proposed extension is less than the present ratio, except for shuttle service with

Table 22
COMPARISON OF FAREBOX RECOVERY RATIOS, BY ALIGNMENT
AND SERVICE TYPE TO SR-4
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE/ALIGNMENT	THROUGH SERVICE			SHUTTLE SERVICE		
	FARES	COST	RATIO	FARES	COST	RATIO
1 - Southern Pacific	\$1.6	\$6.9	23	\$1.2	\$4.9	24
2 - AT&SF Railway	1.9	6.8	28	1.5	4.7	32
3 - Interstate-80	2.5	6.2	40	1.9	4.6	41
4 - San Pablo Avenue	3.0	7.1	42	2.3	4.9	47
5 - Rumrill/Hilltop/I-80	2.9	6.7	43	2.3	4.9	47
13 - Hilltop/I-80	2.3	6.9	33	1.8	4.9	37
14 - AT&SF Railway	1.9	6.8	28	1.5	4.7	32

NOTES: All fare and cost figures are annual, in 1982 millions of dollars.
Ratios are expressed in percent, rounded to the nearest whole number.
Fare revenues are based on mid-range values in Table 14.

Alternatives 4 and 5. In no case do any of the alternatives match the projected 1990 farebox recovery ratio of at least 53 percent.

One apparent anomaly in Table 22 deserves explanation. Some alignment alternatives which have an equal recovery ratio for through services have unequal recoveries for shuttle service. This situation occurs because shuttle service is operated differently than the through service, with layovers at both ends of the line. Depending on the exact cycle time for trains on the route alternative, the ratio of car miles and hours is not constant between the shuttle and through service options. Consequently, it is possible for alternative alignments 4 and 5 to both have a 47 percent farebox recovery for shuttle service, but alignment 5 has a slightly greater farebox recovery for through service (43 as compared with 42 percent).

6.4.2 Extensions Beyond SR-4

The annual incremental operating costs of extensions beyond SR-4 would vary between \$1.4 - \$2.4 million for through service, and \$0.8 - \$1.3 million for shuttle service. As noted in Section 6.3.2, fare revenues are expected to be in the range of \$180,000 - \$270,000. Using the mid-range values of these estimates, an extension beyond State Route 4 would recover only 12 percent of costs for through service, and 17 percent for shuttle service. Under the most optimistic conditions (\$800,000 annual operating cost and \$270,000 annual fare revenues), the incremental Crockett portion of the extension would recover only about 34 percent of costs.

7. SUMMARY EVALUATION OF ALTERNATIVES

This chapter summarizes and draws conclusions from the development and evaluation of the alternatives provided in the previous chapters. The summary discussion is limited to those alternatives which were determined to have sufficient promise to justify further consideration during the course of the study. These alternatives include those identified as listed below (see Figure 6):

- 1 - Southern Pacific
- 2 - AT & SF Railway
- 3 - Interstate-80
- 4 - San Pablo Avenue
- 5 - Rumrill/Hilltop/I-80
- 13 - Hilltop/I-80
- 14 - AT & SF Railway/I-80

In addition, to facilitate comparisons between alternatives, all alternatives were treated here as having a common terminus near the State Route 4 and Interstate-80 Interchange, or near Rodeo (Alternative 1). This terminus was chosen for the following reasons:

1. A terminus near the State Route 4 and Interstate-80 Interchange would provide flexibility for consideration of a future extension to either the north or the east.
2. This interchange area offers an excellent opportunity to "intercept" commute traffic using Interstate-80 or State Route 4.
3. The interchange area appears to have available land resources to support the required BART station, parking areas and tail track which would be required at the terminus.

Given a common terminus point near State Route 4, Alternatives 2 and 14 are identical in alignment from State Route 4 south and can be considered as one alternative. A separate

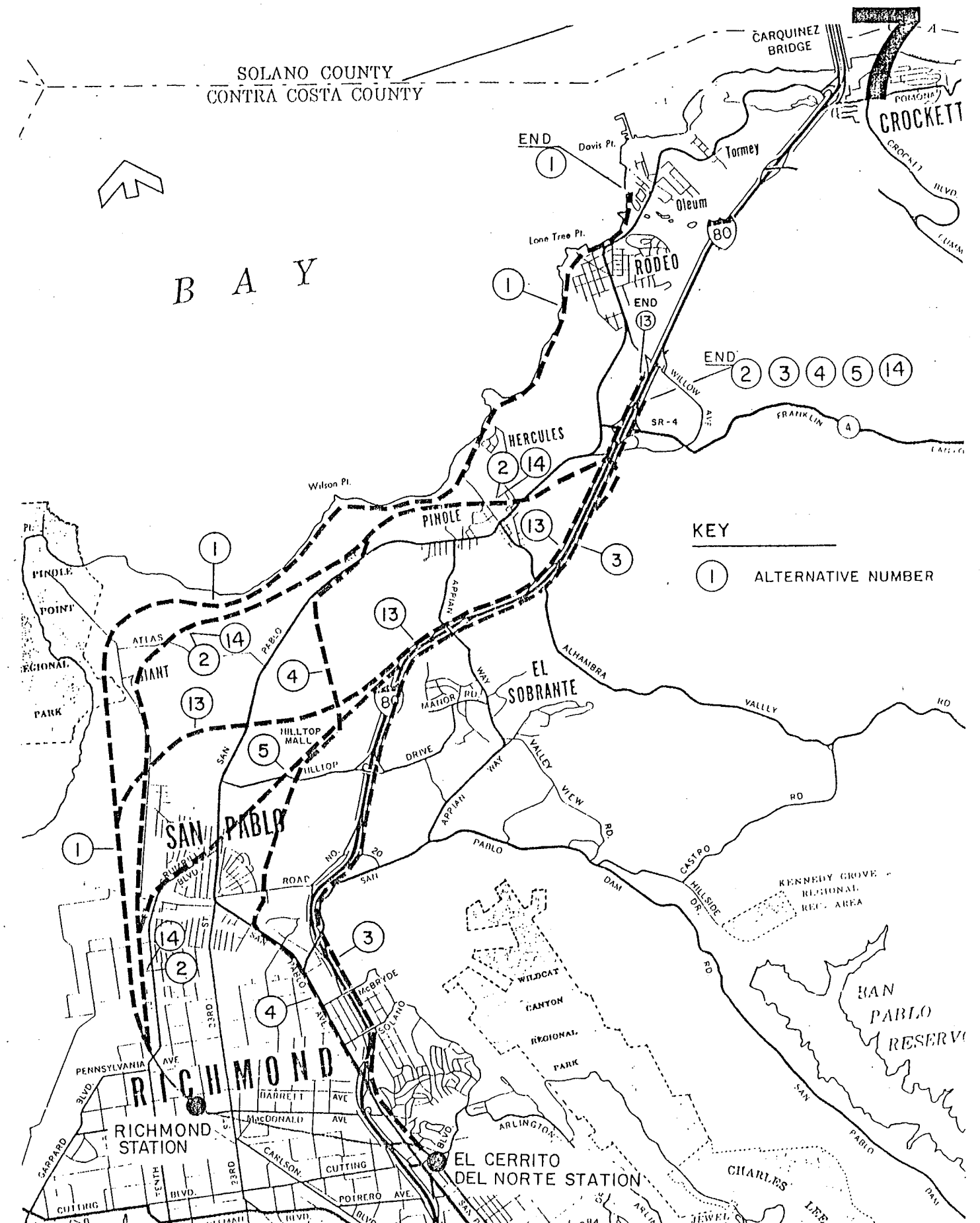


FIGURE 6
ALTERNATIVE BART RAIL EXTENSIONS 1, 2, 3, 4, 5, 13 & 14
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY

section of this chapter discusses the implications of further extensions beyond State Route 4.

7.1 Physical Features

The key physical features of the alternatives are summarized in Table 23. Alternatives 1, 2/14, 5, and 13 would extend directly north from the existing Richmond Station. Alternatives 3 and 4 would extend north from the El Cerrito Del Norte Station. In order to accomplish an extension from El Cerrito Del Norte, a grade separated crossover and junction of the BART tracks would be required north of the station. Extensions from El Cerrito Del Norte would create two BART terminals in the study area, one at the existing Richmond Station and a new terminal near State Route 4. Detailed drawings depicting the alignment and vertical profiles of the alternatives are presented in Appendix E.

7.1.1 Northern Terminus

With the exception of Alternative 1, which follows the Southern Pacific alignment along the Bayfront, all the alternatives could provide a terminus near the State Route 4/ Interstate-80 Interchange area. Alternative 1 would have the disadvantage of reduced accessibility from Interstate-80 and State Route 4, and of reduced flexibility for future extensions as compared with the other alternatives.

7.1.2 Length

The alternatives range from 7.6 to 9.9 miles in length. Alternative 1, which extends from Richmond to Rodeo via the Southern Pacific right-of-way is 1.0 mile longer than any of the other alignments. The shortest alignment is Alternative 5, which extends from the Richmond Station to State

Route 4 via Rumrill Boulevard, Hilltop Mall, and Interstate-80. The remainder of the alternatives are clustered between 8.0 and 8.9 miles in length.

7.1.3 Stations

The majority of the alternatives provide the opportunity for four logically spaced and located stations in the study area. Alternatives 2/14 and 3, however, afford the opportunity for three stations along their alignments, somewhat reducing their relative accessibility from the study area.

7.1.4 Yards and Tail Tracks

Those alignments which extend north of the Richmond Station would offer significant advantages in terms of maintenance and train station facilities. The Richmond Station extensions would not require a new yard in the study area. This is an important consideration, since a new yard would be costly to construct and limited sites are available in the study area which are suitable for a yard facility. These alternatives would require a 3000 foot train storage track (tail track) at the end of the line to reduce the need to deadhead trains taken out of service during the midday and evening all of the way from the end of the line to Richmond and then back when the trains are returned to service.

Alternatives 3 and 4 which extend from El Cerrito Del Norte would require a new yard facility because of their remoteness from the Richmond yard. A potential site for the yard facility has been located in the Refugio Valley east of Interstate-80, adjacent to existing State Route 4. With construction of a new yard along the extension the tail track requirement is reduced to 1000 feet.

Table 23
SUMMARY COMPARISON OF ALTERNATIVES
PHYSICAL FEATURES
BART WEST CONTRA COSTA EXTENSION STUDY

<u>ALTERNATIVE</u>	<u>EXTENSION FROM</u>	<u>NORTH TERMINUS(1)</u>	<u>LENGTH (Miles)</u>	<u>NUMBER OF STATIONS</u>	<u>YARD REQUIREMENTS</u>	<u>TAIL TRACK LENGTH</u>
1 Southern Pacific	Richmond	Rodeo	9.9	4	Use Richmond Yard	3,000 Ft.
2/14 AT & SF (2) Railway	Richmond	SR-4	8.2	3	Use Richmond Yard	3,000 Ft.
3 Inter-State-80	El Cerrito	SR-4	8.1	3	New Yard/ Refugio Valley	1,000 Ft.
4 San Pablo Avenue	El Cerrito	SR-4	8.9	4	New Yard/ Refugio Valley	1,000 Ft.
5 Rumrill/Hill-top/I-80	Richmond	SR-4	7.6	4	Use Richmond Yard	3,000 Ft.
13 Hilltop/I-80	Richmond	SR-4	8.0	4	Use Richmond Yard	3,000 Ft.

- 1) For purposes of comparison all alternatives were terminated at State Route 4 or Rodeo
2) Between Richmond and State Route 4 Alternatives 2 and 14 have identical alignments

7.1.5 Other Features

Other important physical features which distinguish the alternatives are summarized below:

Alternative 1 - This alternative uses the Southern Pacific right-of-way, but must incorporate extensive aerial structures to avoid conflicts with utilities and spur tracks.

Alternative 2/14 - This alternative follows the Santa Fe alignment but requires additional adjacent right-of-way. Conflicts with utilities and spur tracks are much less extensive than those associated with Alternative 1, allowing at-grade construction.

Alternative 3 - This alignment parallels the east side of Interstate-80 through very hilly terrain. Extensive earth cuts and fills, aerial structures and some tunnelling would be required to build this alignment. The alignment would be characterized by several grades which equal BART's maximum design standards, limiting train speeds. This alignment would cross the Hayward Fault on an aerial structure, posing design complexities.

Alternative 4 - This alignment would require an aerial structure down the median of San Pablo Boulevard. The approaches to Hilltop Mall would require steep gradients and extensive tunnelling.

Alternative 5 - Alternative 5 requires an aerial structure in the median of Rumrill Boulevard in San Pablo. Similar to Alternative 4, access to Hilltop Mall would require extensive tunnelling.

Alternative 13 - This alternative would traverse hilly terrain near Hilltop Mall and along the west side of Interstate-80 requiring earth cuts and fills and some tunnelling. Unlike the other alternatives which parallel Interstate-80, this alternative would conflict with the proposed Interstate-80 HOV lane project.

7.2 Capital Costs - Fixed Facilities

The total capital costs for fixed facilities of the alternatives vary significantly, from \$144 million to \$402 million. As shown in Table 24, Alternative 4 would have the greatest total fixed facilities cost primarily due to the tunnelling requirements near Hilltop Mall, the aerial structure required along San Pablo Avenue and the new yard required in the Refugio Valley. Alternatives 1 and 2/14 would require the least investment in capital facilities. This is due to their use of the relatively flat, obstruction-free alignments created by both the Southern Pacific and Santa Fe railroads. The costs per mile for each alternative also vary dramatically from \$17.4 million for Alternative 1 to \$45.2 million for Alternative 4. Alternatives 4 and 5, both of which require costly tunnels to reach Hilltop Mall, are considerably more expensive than the other alternatives.

7.2.1 Vehicle Requirements

The number of additional vehicles required to operate the planned level of service on the extension ranges from 24 vehicles for Alternative 1 to 39 vehicles for Alternative 4 (see Table 24). The number of vehicles required is a direct function of the length of the extension and the average operating speeds which are achievable on each extension. The analysis of vehicle requirements considered two basic service concepts: through service with direct Daly City - State Route 4 trains and shuttle service which would serve only the extension and require a transfer at either the Richmond Station or the El Cerrito Del Norte Station. This summary evaluation of the alternative considers only the through service option in order to simplify comparisons between the alignment alternatives. The costs of the vehicles required would range from \$29 million for Alternative 1 to \$47 million for Alternative 4.

Table 24
SUMMARY COMPARISON OF ALTERNATIVES
CAPITAL COSTS
BART WEST CONTRA COSTA EXTENSION STUDY

<u>ALTERNATIVE</u> ⁽¹⁾	<u>CAPITAL COSTS- FIXED FACILITIES</u> (In 1982 \$ millions)	<u>FIXED FACILITY COST/MILE</u> (In 1982 \$ millions)	<u>NUMBER OF TRAINS VEHICLES REQUIRED</u> ^{(3) (4)}	<u>VEHICLE COSTS</u> (In 1982 \$ millions)	<u>TOTAL CAPITAL COSTS</u> (In 1982 \$ millions)
1 Southern Pacific	\$ 146	\$ 14.7	2/24	\$ 29	\$ 175
2/14 AT & SF Railway ⁽²⁾	144	17.6	2/27	32	176
3 Interstate - 80	183	22.6	3/33	40	223
4 San Pablo Avenue	402	45.2	3/39	47	449
5 Rumrill/Hilltop/I-80	291	38.3	3/38	46	337
13 Hilltop/I-80	165	20.6	3/32	38	203

- (1) For purposes of comparison all alternatives were terminated at State Route 4 or Rodeo
(2) Between Richmond and State Route 4 Alternatives 2 and 14 have identical alignments
(3) Additional BART cars required to operate through service (State Route 4 to Daly City)
(4) Trains required were developed assuming 10 car trains and 15 percent spare requirements.

7.3 Operating Costs, Patronage and Revenues

A summary of the operating costs, patronage and revenue estimates for each alternative is provided in Table 25.

7.3.1 Operating Costs

The estimated annual operating costs of the new extension service would range from \$6.2 million to \$7.1 million. The difference between alternatives is largely a function of the length of the extension. The variation in operating costs is significant. For example, the operating costs for Alternative 4 would be 15 percent greater than those of Alternative 3.

7.3.2 Patronage

A considerable variation in the future patronage generated by the various extension alternatives is anticipated. Table 26 presents the service quality or performance characteristics of the alternatives which would influence patronage. The least patronage is expected for the two railroad related alignment Alternatives 1 and 2/14. The alignments of these alternatives are well to the west of the existing population centers of the study area and are not very accessible from Interstate-80. The greatest patronage is expected on Alternatives 4 and 5. These alignments allow stations at key developed and developing areas of the study area, such as central San Pablo, Hilltop Mall, Pinole, and State Route 4. The other alternatives, 3 and 13, would provide mid-range patronage levels. They offer better accessibility than the two railroad alignments, but are not as well oriented to serve North Richmond and San Pablo as Alternatives 4 and 5.

7.3.3 Fare Revenue/Cost Relationships

The ratio of estimated fare revenues, as derived from the patronage forecast, to the operating costs of the extension provides a direct measure of system productivity. Currently the BART system recovers 45 percent of its operating costs from farebox revenues. The farebox ratio for the extension alternatives would range from 23 percent for Alternative 1 to 43 percent for Alternative 5. The railroad alignment Alternatives 1 and 2/14 have significantly poorer estimated future recovery ratios than the other alternatives.

7.3.4 Operating Cost Per Passenger

Another productivity measure is the operating cost for each one-way passenger trip. This value was measured for both gross patronage (total future ridership on the extension) and incremental patronage (new ridership excluding existing BART riders). The estimated cost to BART for providing service to each new or incremental passenger trip would be \$3.31 to \$6.59. Thus, the cost per passenger trips associated with Alternative 1 would be 100 percent greater than that associated with Alternative 5.

7.4 Environmental Factors

A preliminary environmental assessment of the alternatives was conducted to discern any potentially significant environmental impacts which could be associated with each alternative. The key environmental issues which were identified in areas where significant impacts may occur include:

1. Displacement of Businesses and Homes
2. Traffic or Transportation Impacts

Table 25
SUMMARY COMPARISON OF ALTERNATIVES
OPERATING COSTS, PATRONAGE AND REVENUES
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE ⁽¹⁾	ANNUAL ⁽³⁾ OPERATING COST (In 1982 \$ millions)	ONE-WAY DAILY ⁽⁴⁾ PASSENGER TRIPS	ANNUAL FARE REVENUE ⁽³⁾ (In 1982 \$ millions)	FAREBOX ⁽³⁾ ⁽⁵⁾ RECOVERY RATIO	OPERATING COST/PASSENGER TRIP
1 - Southern Pacific	6.9	5,200 - 8,200	1.2 - 1.9	23	\$ 6.59
2/14 - AT&SF Railway ⁽²⁾	6.8	6,400 - 9,800	1.5 - 2.2	28	5.38
3 - Interstate-80	6.2	8,400 - 13,200	1.9 - 3.0	40	3.66
4 - San Pablo Avenue	7.1	10,000 - 16,000	2.3 - 3.6	42	3.46
5 - Rumrill/Hilltop/I-80	6.7	10,000 - 15,600	2.3 - 3.5	43	3.31
13 - Hilltop/I-80	6.9	7,800 - 12,400	1.8 - 2.8	33	4.33

(1) For purposes of comparison all alternatives were terminated at State Route 4 or Rodeo.

(2) Between Richmond and State Route 4 Alternatives 2 and 14 have identical alignments.

(3) For thru service operating concept, direct State Route 4 to Daly City trains.

(4) Includes existing BART patrons ("old riders").

(5) Ratio of mid-range gross fare revenue to operating cost, thru service.

Table 26
SUMMARY COMPARISON OF ALTERNATIVES (1)
SERVICE PERFORMANCE INDICATORS
BART WEST CONTRA COSTA EXTENSION STUDY

ALTERNATIVE	SPEED MPH	TRAVEL TIMES (MINUTES) (3)				SERVICE COVERAGE (AREAS SERVED) (6)					
		SR-4 To San Francisco (2)	SR-4 To Richmond	SR-4 To El Cerrito	Hilltop To El Cerrito	Central San Pablo	Central Pinole	Hilltop	Hercules	SR-4/I-80	Rodeo
1 - Southern Pacific	43	55.0	14.5	19.5	N/A (5)	NO	YES	NO	YES	NO	YES
2/14 - AT&SF Railway	45	51.5	11.6	16.0	N/A (5)	NO	YES	NO	YES	YES	NO
3 - Interstate-80	42	48.5	24.0 (4)	11.5	5.4	NO	YES	YES	NO	YES	NO
4 - San Pablo Avenue	41	49.1	24.6 (4)	12.5	6.8	YES	YES	YES	NO	YES	NO
5 - Rumrill/Hilltop/I-80	41	51.8	11.8	16.3	11.3	YES	YES	YES	NO	YES	NO
13 - Hilltop/I-80	41	52.5	12.5	17.0	11.3	NO	YES	YES	NO	YES	NO

(1) For purposes of comparison all alternatives are assumed to terminate at State Route 4 or Rodeo.

(2) Montgomery Street Station.

(3) In-Vehicle-Time plus transfer station wait time. Excludes dwell times at boarding station.

(4) Transfer required at El Cerrito Del Norte Station.

(5) This alignment does not serve Hilltop Mall.

(6) Station within approximately one mile of served area.

3. Visual or Aesthetic Impacts
4. Noise Impacts
5. Air Quality Impacts
6. Biological Impacts
7. Geologic Impacts
8. Impacts to Historic Sites, Archeological Sites, and Park Lands.

Table 27 presents preliminary findings of environmental sensitivity for each alternative. Sensitivity ratings are based upon the following ranking system: 1 representing least sensitive, 2 representing moderately sensitive, and 3 representing most sensitive. A summary discussion of the environmental features of each alternative is provided below:

Alternative 1: Southern Pacific Railroad Route

This alignment would utilize an existing transportation corridor. Proximity to the Bay would result in Bay Conservation and Development Commission (BCDC) involvement and potential review by the East Bay Regional Park District. Several rare or endangered species inhabit areas within this route and could be impacted. This route is least accessible to potential users except at its northern terminus. Special engineering would be required for extensive cuts, location on bayfill and one tunnel. Potential parkland and archaeological impacts are likely.

Alternative 2/14: Santa Fe Railway Route

This alignment would result in displacement of several mobile homes. The route would be more accessible to potential users and less prominent visually. Utilizing an existing transportation corridor, this alignment would be one of the three less sensitive alternatives.

Alternative 3: Paralleling East Side of Interstate-80

This alignment would result in several displacements. Utilizing an existing transportation corridor, this route would require extensive cuts, fills and aerial sections that would be highly visible. This alternative crosses the Hayward Fault on an aerial structure, a design problem which must be addressed.

Alternative 4: San Pablo Avenue and Hilltop Mall

This route would serve downtown San Pablo and the Hilltop Mall. Three displacements would be necessary. The aerial section along San Pablo Avenue would be highly visible and could result in traffic and parking related impacts. This urban area contains several receptors sensitive to noise. Potential parkland and historical impacts are likely.

Alternative 5: Rumrill Boulevard

This alignment would result in several displaced mobile homes. By avoiding dense urban areas this alternative would be less sensitive visually and acoustically than other alternatives. Sensitive receptors are minimal for this route.

Alternative 13: Hilltop Mall and Interstate-80 to State Route 4

This route would not result in any displacements and would be readily accessible to users. By avoiding urban street rights-of-way, traffic disruptions during construction would be minimized. Extensive cuts and fills and a tunnel section would require special design consideration.

7.5 Extensions North of State Route 4

Initially many of the alternatives were developed with a northern terminus at either Crockett or Cummings Skyway. To

Table 27

SUMMARY EVALUATION OF ALTERNATIVES
 ENVIRONMENTAL SENSITIVITY
 BART WEST CONTRA COSTA EXTENSION STUDY

<u>ENVIRONMENTAL ISSUE</u>	<u>ALTERNATIVE</u>					
	<u>1</u>	<u>2/14</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>13</u>
Displacements	1	2	2	2	2	1
Traffic Impacts	3	2	1	3	2	1
Visual and Aesthetics	2	1	3	3	2	3
Noise	1	2	2	3	1	1
Air Quality	1	1	1	1	1	1
Biology	3	2	2	2	2	1
Geology	3	2	2	2	2	3
Historic Sites/Archaeo- logy/Park lands	3	2	2	3	1	1

Note: Sensitivity ratings are based on the following ranking; 1 representing least sensitive, 2 representing moderately sensitive, and 3 representing most sensitive.

facilitate comparisons between alternatives and to provide a logical northern terminus in the study area which would not rule out future extensions, the terminus was modified to either State Route 4 or Rodeo. This section summarizes the implications of a further extension to either Crockett or Cummings Skyway.

7.5.1 Crockett Extensions

Alternatives 1 and 2 were originally planned to terminate in Crockett. An extension from Rodeo to Crockett would require an additional 3.3 miles of BART trackage (excluding tail tracks) and \$113 million dollars in fixed facilities cost. This cost represents 78 percent of the capital costs for Alternatives 1 and 2 with a Rodeo terminus. The additional daily patronage generated by a Crockett station would be modest, approximately 800-1,200 one-way passenger trips/day. The incremental operating cost per passenger trip would be about \$11.15, depending on the alignment and type of service. Additionally, the Crockett Station and tail track would be disruptive to the Crockett waterfront area and would considerably complicate the option of a future extension across the Carquinez Strait.

7.5.2 Cummings Skyway Extensions

An extension from State Route 4 to Cummings Skyway would involve an additional 2.7 miles of BART construction and \$51.6 million, representing an increase of 28 percent in the total cost of the extension of Alternative 3 which terminates at SR-4. The additional patronage generated by this extension would also be low, since most patrons, particularly Interstate-80 commuters, could just as easily use the State Route 4 Station. Incremental operating costs per new passenger trip of \$9.76 are estimated for a further extension to Cummings Skyway.

APPENDIX

Appendix A

BART UNIT COST ASSUMPTIONS

Appendix A
BART UNIT COST ASSUMPTIONS

<u>Item</u>	<u>Unit</u>	<u>1982 \$</u>
<u>Trackwork</u>		
1 At Grade Track	Trackfoot	137
2 Track on aerial structure	Trackfoot	100
3 Yard track	Trackfoot	73
4 Turnout #20	EA	30,000
5 Turnout #15	EA	25,000
6 Turnout #10	EA	18,000
7 Turnout #8 (Yard)	EA	15,000
<u>Structures and Civil Work</u>		
1 Earthwork:		
a) Major Cuts (in excess of 3 ft.)	Cu. Yd.	6.50
b) Rock excavation	Cu. Yd.	72.80
c) Major fills (in excess of 3 ft.)	Cu. Yd.	4.70
2 Cut and cover structure (double track)	Trackfoot	3,400
3 Tunnel	Trackfoot	8,000
4 BART aerial structure (single)	LF	1,620
5 BART aerial structure (double track)	LF	2,163
6 Major Culvert	SF	42
7 Highway concrete box girder bridge:		
a) Span: L<130'	SF	55
b) Span: 130'<L<160'	SF	74
c) Span: 160'<L<200'	SF	92
8 Pedestrian overcrossing	SF	50
9 Pumping plant	EA	277,000

BART UNIT COST ASSUMPTIONS (Cont'd)

<u>Item</u>	<u>Unit</u>	<u>1982 \$</u>
10 Retaining walls:		
a) Height 6' to 10'	LF	290
b) Height 12' to 20'	LF	880
11 40 ft. wide city street relocation	LF	225
12 Railroad relocation	Trackmile	360,000
<u>Utility Relocation</u>		
1 Site-specific requirements	LS	-
<u>Track Electrification</u>		
1 Traction power (substations @ 1.5 mi.)	Dbl. Trackft.	327
<u>Train Control</u>		
1 Train control complete	Dbl. Trackft.	208
<u>Communications</u>		
1 Train communications complete	Dbl. Trackft.	48
<u>Stations (fully equipped)</u>		
1 At-grade station	EA	2,965,000
2 Aerial station	EA	5,240,000
3 Cut and cover subway station	EA	28,135,000
<u>Parking Facilities</u>		
1 Parking lot space	EA	2,372
2 Two level parking structure space	EA	4,400
3 50' wide access road (2 lane)	LF	280

BART UNIT COST ASSUMPTIONS (Cont'd)

<u>Item</u>	<u>Unit</u>	<u>1982 \$</u>
<u>Additional Items</u>		
1 Fencing (CL6)	LF	7
2 Concrete barrier	LF	93
3 Landscaping	SF	4
4 Temporary detour maintenance	LS	100,000
 <u>Storage Facilities</u>		
1 Yard track (10,000 T.F.) & appurtenances	LS	5,693,000,
2 Tail track 1,000 LF (Site Specific)	LS	-
3 Tail track 3,000 LF (Site Specific)	LS	-
 <u>Transit Vehicles</u>		
1 Model 'C' Cars	EA	1,200.000

Appendix B

SEGMENT COST ESTIMATES

Table B-1
BART CAPITAL COST ESTIMATES
1982 Dollars (000's)

Estimated Capital Costs and Fixed
Facilities Alternative Alignments -
BART West Contra Costa Extension

Capital Cost Items	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
1. Trackwork	\$ 18,579	\$ 19,574	\$ 13,640	\$ 18,469	\$ 13,899	\$ 16,813	\$ 18,789	\$ 19,364
2. Structures & Civil Work	84,602	87,651	87,131	193,234	147,725	173,921	78,883	93,407
3. Utility Relocation	18,698	8,930	800	13,100	1,520	13,630	11,740	16,183
4. Track Electrification	22,890	23,383	18,737	24,528	17,756	21,419	22,001	24,199
5. Train Control	14,562	14,874	11,918	15,602	11,294	13,626	14,042	15,394
6. Communication	3,288	3,432	2,750	3,600	2,606	3,144	3,240	3,552
7. Stations	17,100	19,375	18,685	47,510	46,820	45,235	17,100	19,375
8. Parking Facilities	3,922	4,382	5,232	5,093	5,280	4,523	3,574	4,730
9. Additional Items	1,034	935	1,522	910	1,798	920	936	1,033
10. Storage Facilities	2,848	2,848	11,559	6,660	6,615	2,848	2,848	2,848
Base Total	187,523	185,384	172,074	328,706	255,313	296,079	173,153	200,085
+15% Contingencies	28,128	27,808	25,811	49,306	38,297	44,412	25,973	30,013
Construction Costs	215,651	213,192	197,885	378,012	293,610	340,491	199,126	230,098
+15% Agency Cost*	32,348	31,979	29,683	56,702	44,041	51,074	29,869	34,515
Subtotal	247,999	245,170	227,568	434,714	8,454	391,564	228,995	264,613
Right-of-Way Cost	10,733	7,339	6,513	17,959	8,454	11,257	10,612	13,710
Relocation Cost	-	1,850	490	1,220	400	930	1,330	130
GRAND ESTIMATED TOTAL	258,732	254,359	234,571	453,893	346,505	403,751	240,937	278,453

NOTES: 1) Vehicle fleet costs are not included.

2) Row costs for tailtrack and yard are included.

*(Eng. & Cost Mangt.)

Table B-1 (Continued)
BART CAPITAL COST ESTIMATES
1983 Dollars (000's)

Capital Cost Items	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14	Alternative 15
1. Trackwork	\$ 17,494	\$ 17,684	\$ 17,598	\$ 14,331	\$ 9,974	\$ 17,532	\$ 14,770
2. Structures & Civil Work	121,966	184,457	182,698	172,134	51,880	56,815	158,261
3. Utility Relocation	9,190	15,910	10,820	9,910	1,688	1,440	3,800
4. Track Electrification	23,217	23,218	22,729	18,050	13,734	20,047	19,555
5. Train Control	14,770	14,770	14,458	11,484	8,736	12,750	12,438
6. Communication	3,408	3,408	3,336	2,650	2,016	2,942	2,870
7. Stations	21,650	45,235	47,510	44,545	18,685	16,590	46,820
8. Parking Facilities	5,591	4,285	5,331	4,787	5,769	4,387	5,042
9. Additional Items	1,189	911	919	846	985	1,381	1,789
10. Storage Facilities	6,660	6,660	2,848	2,848	4,971	6,615	11,559
Base Total	225,135	316,538	308,247	281,585	118,438	140,499	276,904
+15% Contingencies	33,770	47,481	46,237	42,238	17,766	21,075	41,536
Construction Costs	258,905	364,019	354,484	323,823	136,204	161,574	318,440
+15% Agency Cost*	38,836	54,306	53,173	48,573	20,431	24,236	47,766
Subtotal	297,741	418,622	407,657	372,396	156,634	185,810	366,206
Right-of-Way Cost	9,065	14,857	14,364	11,664	8,764	11,253	11,663
Relocation Cost	490	700	650	400	-	1,850	570
GRAND ESTIMATED TOTAL	307,296	434,179	422,671	384,460	165,398	198,913	378,439

NOTES: 1) Vehicle fleet costs are not included.
2) Row costs for tailtrack and yard are included.
*(Enq. & Cost Manq.)

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 1A/1

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	2,649
2. Structures and Civil Work	16,152
3. Utility Relocation	1,388
4. Track Electrification	3,270
5. Train Control	2,080
6. Communications	480
7. Stations	5,240
8. Parking Facilities	1,005
9. Additional Items	155
	<hr/>
Base Total	32,419
+15% Contingencies	<u>4,863</u>
Construction Costs	37,282
+15% Agency Cost ⁽²⁾	<u>5,592</u>
Subtotal	<u>42,874</u>
Right-of-Way Cost	1,699
Relocation Cost	-
Estimated Grand Total	<u>\$44,573</u>

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 1A/2

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	6,858
2. Structures and Civil Work	19,447
3. Utility Relocation	6,270
4. Track Electrification	8,829
5. Train Control	5,616
6. Communications	1,296
7. Stations	2,965
8. Parking Facilities	530
9. Additional Items	473
	<hr/>
Base Total	52,284
+15% Contingencies	<u>7,843</u>
Construction Costs	60,127
+15% Agency Cost ⁽²⁾	<u>9,019</u>
Subtotal	<u>69,146</u>
Right-of-Way Cost	3,242
Relocation Cost	-
Estimated Grand Total	<u>\$72,388</u>

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 1B

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	274
2. Structures and Civil Work	24
3. Utility Relocation	295
4. Track Electrification	327
5. Train Control	208
6. Communications	48
7. Stations	-
8. Parking Facilities	-
9. Additional Items	14
	<hr/>
Base Total	1,190
+15% Contingencies	179
Construction Costs	<hr/> 1,369
+15% Agency Cost ⁽²⁾	205
Subtotal	<hr/> 1,574
Right-of-Way Cost	104
Relocation Cost	-
Estimated Grand Total	<hr/> \$1,678

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 1C

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	2,466
2. Structures and Civil Work	1,589
3. Utility Relocation	2,655
4. Track Electrification	2,943
5. Train Control	1,872
6. Communications	432
7. Stations	2,965
8. Parking Facilities	852
9. Additional Items	126
	<hr/>
Base Total	15,900
+15% Contingencies	2,385
Construction Costs	<hr/> 18,285
+15% Agency Cost ⁽²⁾	2,743
Subtotal	<hr/> 21,028
Right-of-Way Cost	1,654
Relocation Cost	-
Estimated Grand Total	<hr/> \$22,682

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 1D

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	6,332
2. Structures and Civil Work	47,390
3. Utility Relocation	8,090
4. Track Electrification	7,521
5. Train Control	4,786
6. Communications	1,104
7. Stations	5,930
8. Parking Facilities	1,535
9. Additional Items	266
	<hr/>
Base Total	82,954
+15% Contingencies	12,443
Construction Costs	95,397
+15% Agency Cost ⁽²⁾	14,310
Subtotal	109,707
Right-of-Way Cost	3,317
Relocation Cost	-
Estimated Grand Total	<hr/> \$113,024

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 2A

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	2,204
2. Structures and Civil Work	7,146
3. Utility Relocation	120
4. Track Electrification	1,962
5. Train Control	1,248
6. Communications	288
7. Stations	-
8. Parking Facilities	-
9. Additional Items	184
	<hr/>
Base Total	13,152
+15% Contingencies	1,973
Construction Costs	15,125
+15% Agency Cost ⁽²⁾	2,269
Subtotal	17,394
Right-of-Way Cost	598
Relocation Cost	400
Estimated Grand Total	<hr/> \$18,392

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 2B

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	6,691
2. Structures and Civil Work	22,676
3. Utility Relocation	510
4. Track Electrification	8,339
5. Train Control	5,304
6. Communications	1,224
7. Stations	5,240
8. Parking Facilities	475
9. Additional Items	304
	<hr/>
Base Total	50,763
+15% Contingencies	7,614
Construction Costs	<hr/> 58,377
+15% Agency Cost ⁽²⁾	8,757
Subtotal	<hr/> 67,134
Right-of-Way Cost	3,715
Relocation Cost	800
Estimated Grand Total	<hr/> \$71,649

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 2C

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	411
2. Structures and Civil Work	21
3. Utility Relocation	30
4. Track Electrification	491
5. Train Control	312
6. Communications	72
7. Stations	2,965
8. Parking Facilities	712
9. Additional Items	21
	<hr/>
Base Total	5,035
+15% Contingencies	755
Construction Costs	<hr/> 5,790
+15% Agency Cost ⁽²⁾	869
Subtotal	<hr/> 6,659
Right-of-Way Cost	1,048
Relocation Cost	130
Estimated Grand Total	<hr/> \$7,837

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 2D

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	959
2. Structures and Civil Work	49
3. Utility Relocation	70
4. Track Electrification	1,145
5. Train Control	728
6. Communications	168
7. Stations	-
8. Parking Facilities	-
9. Additional Items	49
	<hr/>
Base Total	3,168
+15% Contingencies	475
Construction Costs	<hr/> 3,643
+15% Agency Cost ⁽²⁾	546
Subtotal	<hr/> 4,189
Right-of-Way Cost	413
Relocation Cost	390
Estimated Grand Total	<hr/> \$4,992

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 2E/1

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	1,418
2. Structures and Civil Work	5,748
3. Utility Relocation	110
4. Track Electrification	1,799
5. Train Control	1,144
6. Communications	264
7. Stations	-
8. Parking Facilities	-
9. Additional Items	62
	<hr/>
Base Total	10,545
+15% Contingencies	1,582
Construction Costs	<hr/> 12,127
+15% Agency Cost ⁽²⁾	1,819
Subtotal	<hr/> 13,946
Right-of-Way Cost	601
Relocation Cost	130
Estimated Grand Total	<hr/> \$14,677

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 2E/2

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	500
2. Structures and Civil Work	2,408
3. Utility Relocation	-
4. Track Electrification	818
5. Train Control	520
6. Communications	120
7. Stations	5,240
8. Parking Facilities	1,660
9. Additional Items	-
	<hr/>
Base Total	11,266
+15% Contingencies	1,690
Construction Costs	<hr/> 12,956
+15% Agency Cost ⁽²⁾	1,943
Subtotal	<hr/> 14,899
Right-of-Way Cost	2,124
Relocation Cost	-
Estimated Grand Total	<hr/> \$17,023

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 3A

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	5,593
2. Structures and Civil Work	56,483
3. Utility Relocation	800
4. Track Electrification	8,502
5. Train Control	5,408
6. Communications	1,248
7. Stations	5,240
8. Parking Facilities	1,376
9. Additional Items	126
	<hr/>
Base Total	84,776
+15% Contingencies	12,716
Construction Costs	<hr/> 97,492
+15% Agency Cost ⁽²⁾	14,624
Subtotal	<hr/> 112,116
Right-of-Way Cost	785
Relocation Cost	490
Estimated Grand Total	<hr/> \$113,391

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 3B

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	3,322
2. Structures and Civil Work	10,426
3. Utility Relocation	-
4. Track Electrification	4,186
5. Train Control	2,662
6. Communications	614
7. Stations	5,240
8. Parking Facilities	852
9. Additional Items	619
Base Total	27,921
+15% Contingencies	4,188
Construction Costs	32,109
+15% Agency Cost ⁽²⁾	4,816
Subtotal	36,925
Right-of-Way Cost	374
Relocation Cost	-
Estimated Grand Total	\$37,299

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 3C/1

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	2,247
2. Structures and Civil Work	14,756
3. Utility Relocation	-
4. Track Electrification	3,008
5. Train Control	1,914
6. Communications	442
7. Stations	5,240
8. Parking Facilities	1,744
9. Additional Items	180
Base Total	29,531
+15% Contingencies	4,429
Construction Costs	33,960
+15% Agency Cost ⁽²⁾	5,094
Subtotal	39,054
Right-of-Way Cost	1,200
Relocation Cost	-
Estimated Grand Total	\$40,254

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 3C/2

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	2,578
2. Structures and Civil Work	5,466
3. Utility Relocation	-
4. Track Electrification	3,041
5. Train Control	1,934
6. Communications	446
7. Stations	2,965
8. Parking Facilities	1,260
9. Additional Items	597
	<hr/>
Base Total	18,287
+15% Contingencies	2,743
Construction Costs	21,030
+15% Agency Cost ⁽²⁾	3,154
Subtotal	24,184
Right-of-Way Cost	640
Relocation Cost	-
Estimated Grand Total	<hr/> \$24,824

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 4A

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	5,090
2. Structures and Civil Work	80,493
3. Utility Relocation	3,800
4. Track Electrification	7,031
5. Train Control	4,472
6. Communications	1,032
7. Stations	5,240
8. Parking Facilities	474
9. Additional Items	343
	<hr/>
Base Total	107,975
+15% Contingencies	16,196
Construction Costs	124,171
+15% Agency Cost ⁽²⁾	18,626
Subtotal	142,797
Right-of-Way Cost	2,585
Relocation Cost	210
Estimated Grand Total	<hr/> \$145,592

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 4B

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	2,700
2. Structures and Civil Work	54,912
3. Utility Relocation	1,000
4. Track Electrification	4,415
5. Train Control	2,808
6. Communications	648
7. Stations	28,135
8. Parking Facilities	712
9. Additional Items	120
Base Total	95,450
+15% Contingencies	14,318
Construction Costs	109,768
+15% Agency Cost ⁽²⁾	16,465
Subtotal	126,233
Right-of-Way Cost	2,336
Relocation Cost	-
Estimated Grand Total	\$128,569

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 5A

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	2,015
2. Structures and Civil Work	62,811
3. Utility Relocation	1,400
4. Track Electrification	3,270
5. Train Control	2,080
6. Communications	480
7. Stations	5,240
8. Parking Facilities	712
9. Additional Items	168
Base Total	78,176
+15% Contingencies	11,726
Construction Costs	89,902
+15% Agency Cost ⁽²⁾	13,485
Subtotal	103,388
Right-of-Way Cost	1,312
Relocation Cost	-
Estimated Grand Total	\$104,700

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 5B

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	1,533
2. Structures and Civil Work	47,120
3. Utility Relocation	-
4. Track Electrification	2,289
5. Train Control	1,456
6. Communications	336
7. Stations	28,135
8. Parking Facilities	712
9. Additional Items	50
	<hr/>
Base Total	81,631
+15% Contingencies	12,245
Construction Costs	<u>93,876</u>
+15% Agency Cost ⁽²⁾	14,081
Subtotal	<u>107,957</u>
Right-of-Way Cost	2,870
Relocation Cost	-
Estimated Grand Total	<u>\$110,827</u>

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: Y1

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	1,188
2. Structures and Civil Work	5,454
3. Utility Relocation	300
4. Track Electrification	1,700
5. Train Control	1,082
6. Communications	250
7. Stations	5,240
8. Parking Facilities	1,828
9. Additional Items	129
	<hr/>
Base Total	17,171
+15% Contingencies	2,576
Construction Costs	<u>19,747</u>
+15% Agency Cost ⁽²⁾	2,962
Subtotal	<u>22,709</u>
Right-of-Way Cost	952
Relocation Cost	-
Estimated Grand Total	<u>\$23,661</u>

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: Y2

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	1,059
2. Structures and Civil Work	2,213
3. Utility Relocation	-
4. Track Electrification	1,308
5. Train Control	832
6. Communications	192
7. Stations	-
8. Parking Facilities	-
9. Additional Items	49
	<hr/>
Base Total	5,653
+15% Contingencies	849
Construction Costs	6,502
+15% Agency Cost ⁽²⁾	975
Subtotal	7,477
Right-of-Way Cost	1,898
Relocation Cost	-
Estimated Grand Total	\$9,375

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: Y3

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	803
2. Structures and Civil Work	2,891
3. Utility Relocation	300
4. Track Electrification	981
5. Train Control	624
6. Communications	144
7. Stations	-
8. Parking Facilities	-
9. Additional Items	123
	<hr/>
Base Total	5,866
+15% Contingencies	880
Construction Costs	6,746
+15% Agency Cost ⁽²⁾	1,012
Subtotal	7,758
Right-of-Way Cost	440
Relocation Cost	-
Estimated Grand Total	8,198

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: Y4

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	702
2. Structures and Civil Work	5,128
3. Utility Relocation	500
4. Track Electrification	981
5. Train Control	624
6. Communications	144
7. Stations	5,420
8. Parking Facilities	1,940
9. Additional Items	115
	<hr/>
Base Total	15,554
+15% Contingencies	2,333
Construction Costs	17,887
+15% Agency Cost ⁽²⁾	2,683
Subtotal	20,570
Right-of-Way Cost	1,478
Relocation Cost	-
Estimated Grand Total	<hr/> \$22,048

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: Y5

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	2,069
2. Structures and Civil Work	10,581
3. Utility Relocation	100
4. Track Electrification	2,289
5. Train Control	1,456
6. Communications	336
7. Stations	-
8. Parking Facilities	-
9. Additional Items	49
	<hr/>
Base Total	16,880
+15% Contingencies	2,532
Construction Costs	19,412
+15% Agency Cost ⁽²⁾	2,912
Subtotal	22,324
Right-of-Way Cost	1,320
Relocation Cost	-
Estimated Grand Total	<hr/> \$23,644

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: 13

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	7,325
2. Structures and Civil Work	35,728
3. Utility Relocation	300
4. Track Electrification	10,464
5. Train Control	6,656
6. Communications	1,536
7. Stations	13,445
8. Parking Facilities	4,764
9. Additional Items	830
	<hr/>
Base Total	81,048
+15% Contingencies	12,157
Construction Costs	93,205
+15% Agency Cost ⁽²⁾	13,981
Subtotal	107,186
Right-of-Way Cost	7,065
Relocation Cost	-
Estimated Grand Total	<hr/> \$114,251

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: X

<u>Item</u>	<u>Cost</u> <u>1982 Dollars (000's)</u> ⁽¹⁾
1. Trackwork	411
2. Structures and Civil Work	28
3. Utility Relocation	40
4. Track Electrification	490
5. Train Control	312
6. Communications	72
7. Stations	-
8. Parking Facilities	-
9. Additional Items	21
	<hr/>
Base Total	1,374
+15% Contingencies	206
Construction Costs	1,580
+15% Agency Cost ⁽²⁾	237
Subtotal	1,817
Right-of-Way Cost	176
Relocation Cost	-
Estimated Grand Total	<hr/> \$1,993

(1) Excludes yard and tail track requirements.

(2) Includes engineering and construction management.

Appendix C

STATION PARKING REQUIREMENTS

ESTIMATED CAPITAL COST
WEST CONTRA COSTA EXTENSION

SEGMENT: Z

Item	Cost 1982 Dollars (000's) ⁽¹⁾
1. Trackwork	274
2. Structures and Civil Work	17
3. Utility Relocation	30
4. Track Electrification	327
5. Train Control	208
6. Communications	48
7. Stations	-
8. Parking Facilities	-
9. Additional Items	14
Base Total	918
+15% Contingencies	138
Construction Costs	1,056
+15% Agency Cost ⁽²⁾	158
Subtotal	1,214
Right-of-Way Cost	112
Relocation Cost	-
Estimated Grand Total	\$1,326

TAIL TRACK COSTS (IN 1982 DOLLARS \$000)

COST ITEM	END SEGMENT					
	1D		3 C/2		13	
	1,000LF	3,000LF	1,000LF	3,000LF	1,000LF	3,000LF
Trackwork	334	942	334	942	260	868
Structures & Civil Work	25	76	1,294	3,880	1,328	2,316
Utility Relocation	10	30	-	-	-	-
Track Electrification	327	981	327	981	327	981
Train Control	208	624	208	624	208	624
Communication	48	144	48	144	48	144
Additional Items	15	43	16	44	8	38
Base Total	967	2,840	2,227	6,615	2,179	4,971
Right-of-Way	239	717	480	1,440	Ø	Ø

NOTE: The appropriate base total cost for the tail tracks is included in the Capital Cost Estimate item "Storage Facilities" of each Alignment Alternative of Table B-1.

(1) Excludes yard and tail track requirements.
(2) Includes engineering and construction management.

Appendix C
PARKING REQUIREMENTS AT STATIONS
West Contra Costa BART Extension

<u>Station</u>	<u>Spaces</u>
Vale Avenue	200
Hilltop Mall	300
San Pablo (El Portal)	300
Parr Boulevard	400
Atlas Road	200
Pinole	300
SR-4	700
Rodeo	300
Crockett	300
Cummings Skyway	300

NOTE: Based on the upper range of the station patronage forecasts for each station (Interim Report #2, Table 8, Page 27).

Compared to: Oakland West (400 spaces), Lake Merritt (225), El Cerrito del Norte (1,100), Richmond (800), North Berkeley (500).

2-1-83

Appendix D

GLOSSARY

G L O S S A R Y

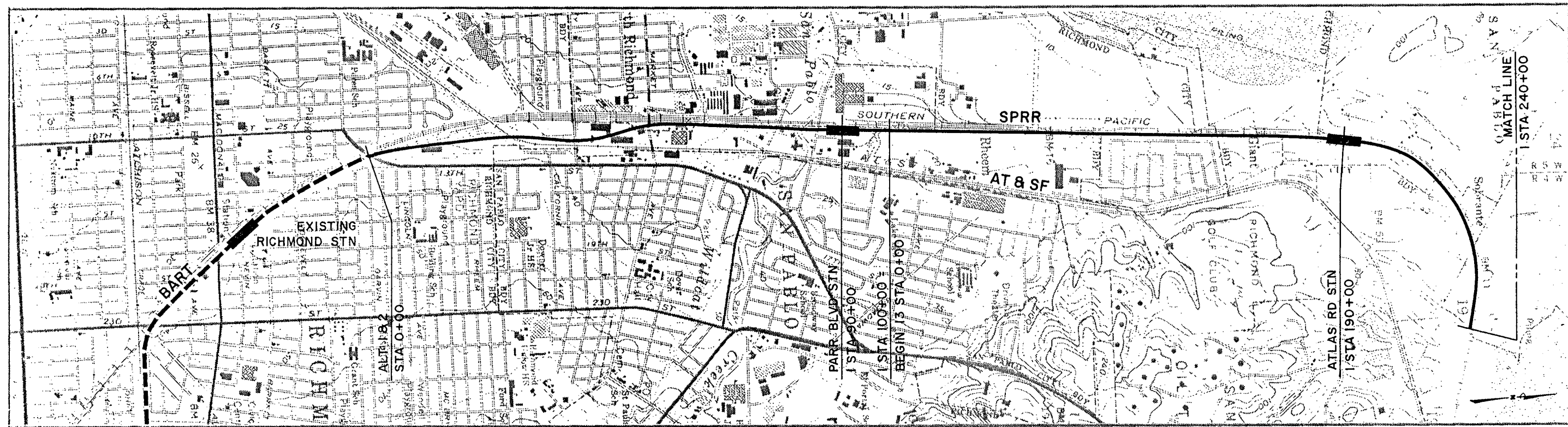
DAS	Data Acquisition System. A computerized system which collects origin-destination information by time of day through BART's fare gates (exit gates).
Dwell	Time spent by a train in a passenger station.
KE Track	A third track currently being completed in downtown Oakland. The track extends from just south of MacArthur to just east of Oakland West. (M-line side Oakland wye). The name of the KE track was recently changed to the MX-CX track.
Performance Level 2	One of six performance levels used to adjust train performance. PL-2 is the level used for train scheduling.
wye	A railroad track arrangement that permits direct double-track train movement between all lines. The wye track arrangement is in the shape of a triangle.

Appendix E

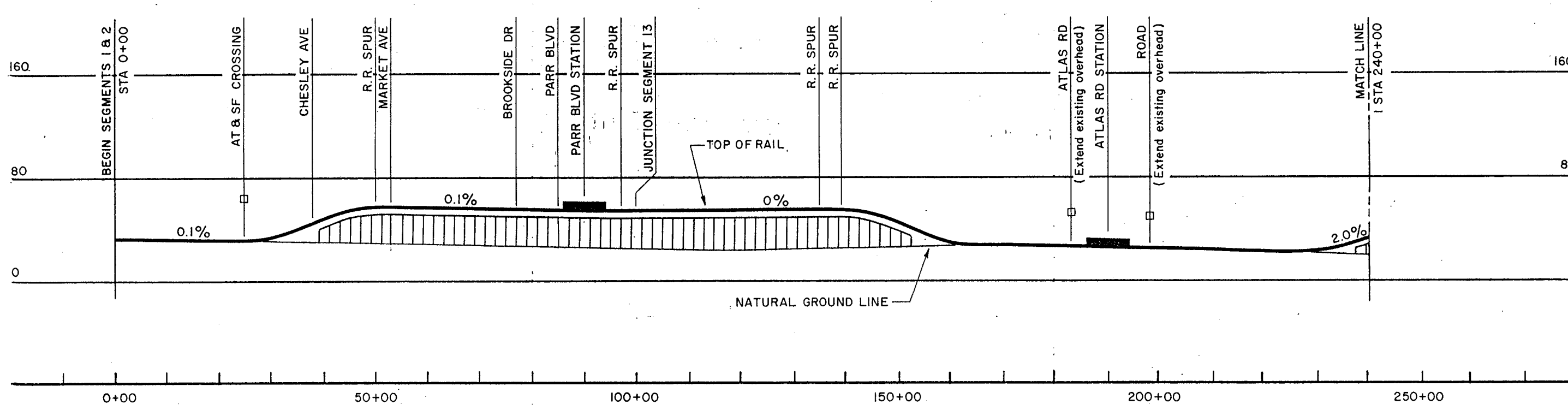
ALIGNMENT AND PROFILE DRAWINGS

NOTE:

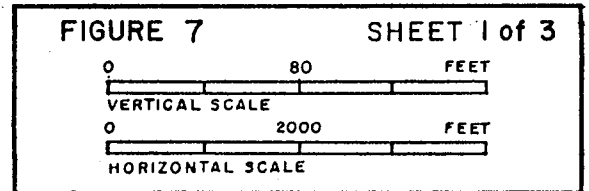
VERTICAL LINES UNDER AERIAL STRUCTURES
ARE SYMBOLIC ONLY AND DO NOT REPRESENT
ACTUAL COLUMN LOCATIONS.

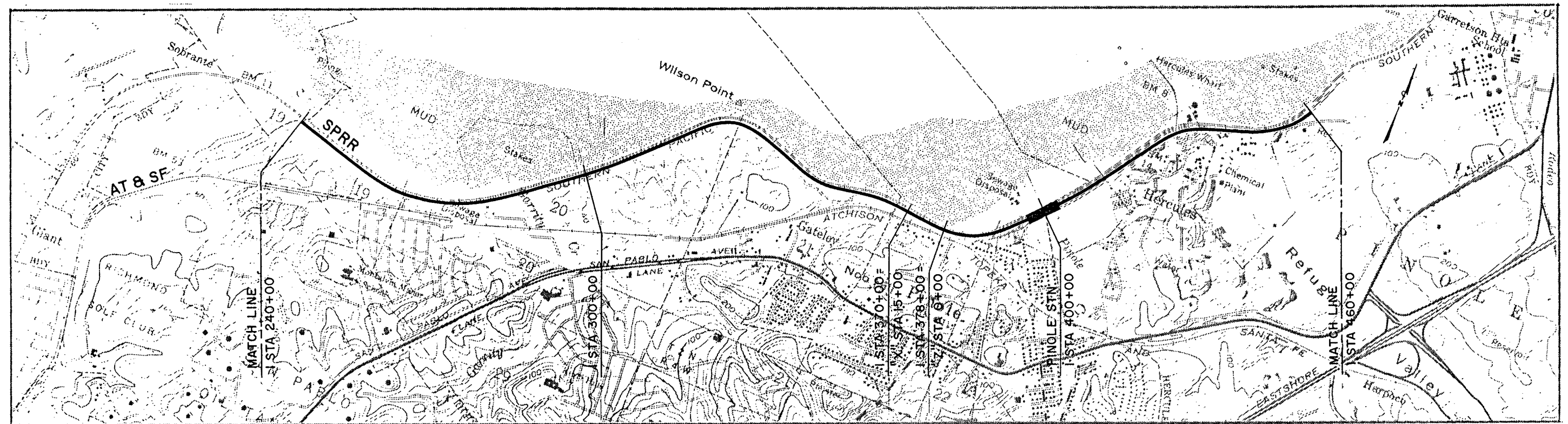


240 240



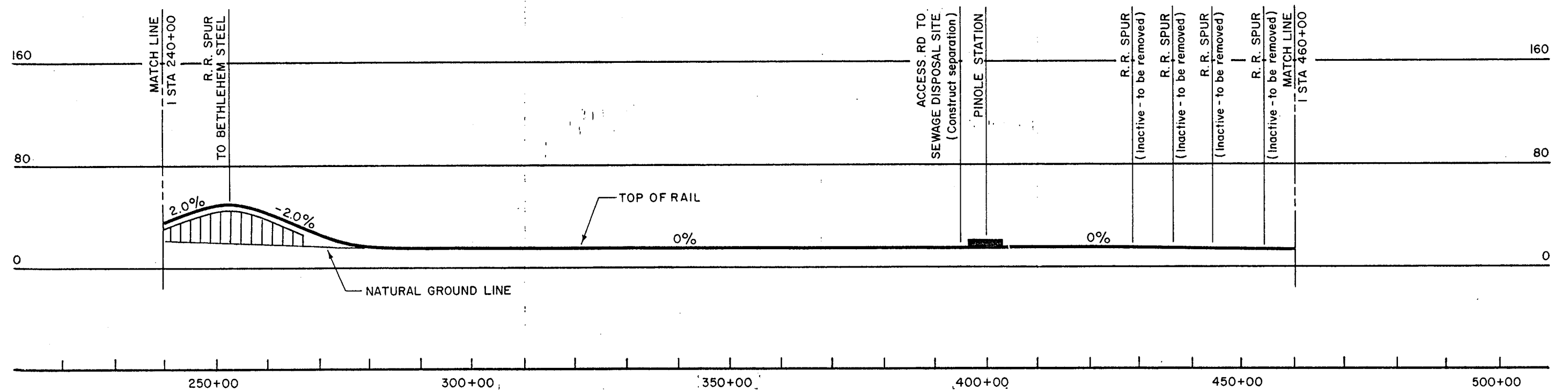
ALIGNMENT ALTERNATIVE I
PARALLELING THE SOUTHERN PACIFIC R.R. LINE (Segment IA)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



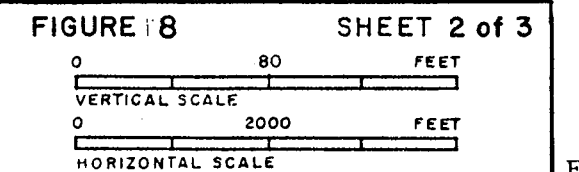


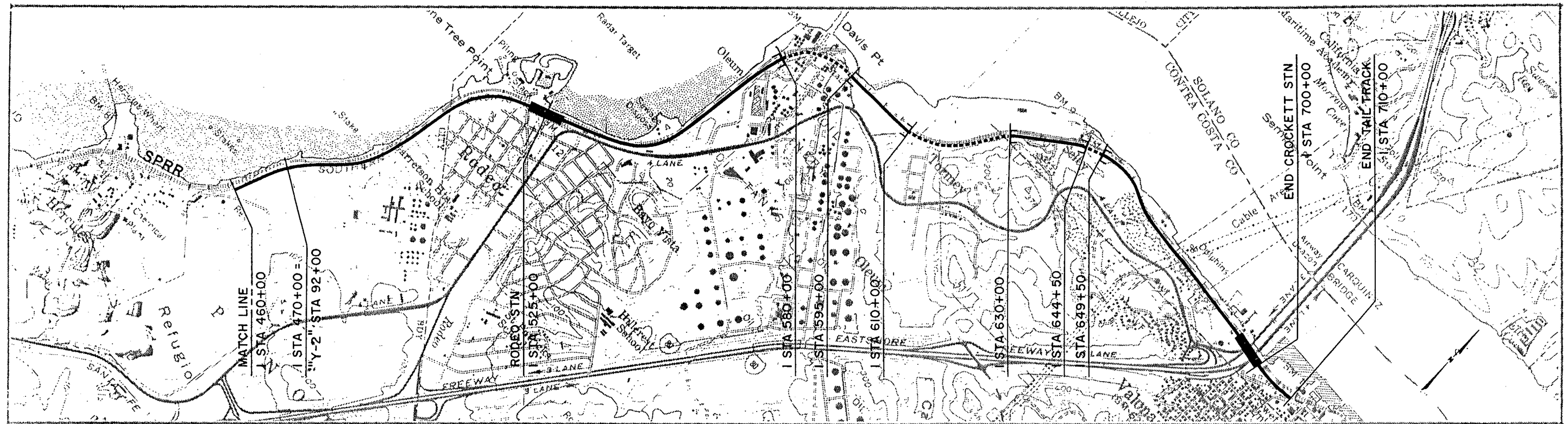
240

240



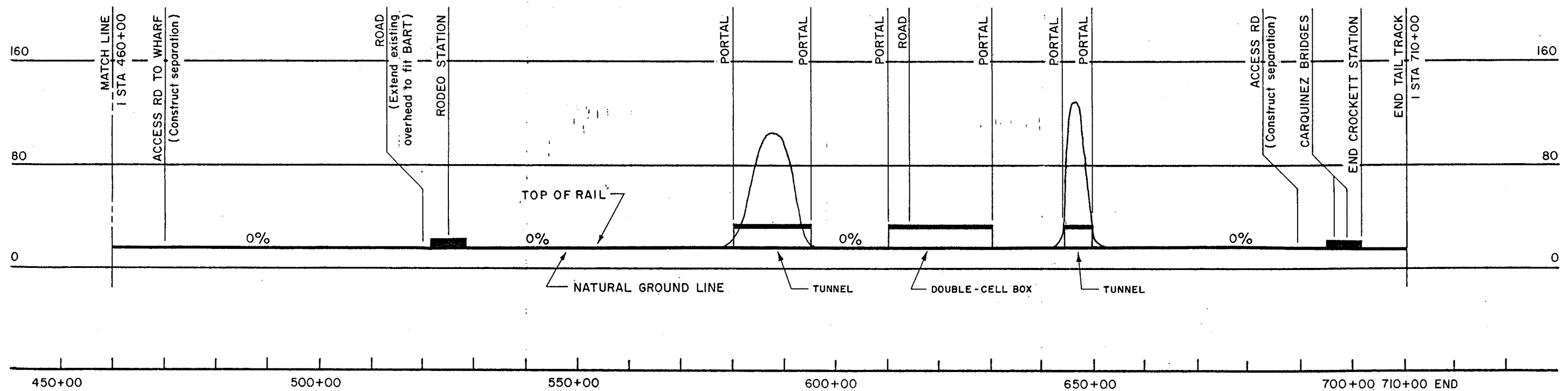
ALIGNMENT ALTERNATIVE I
PARALLELING THE SOUTHERN PACIFIC R.R. LINE (Segments IA, IB, IC)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



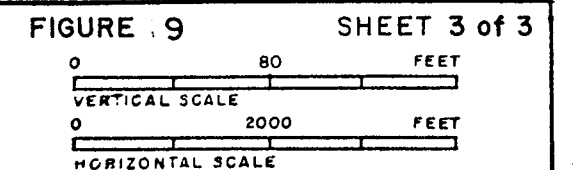


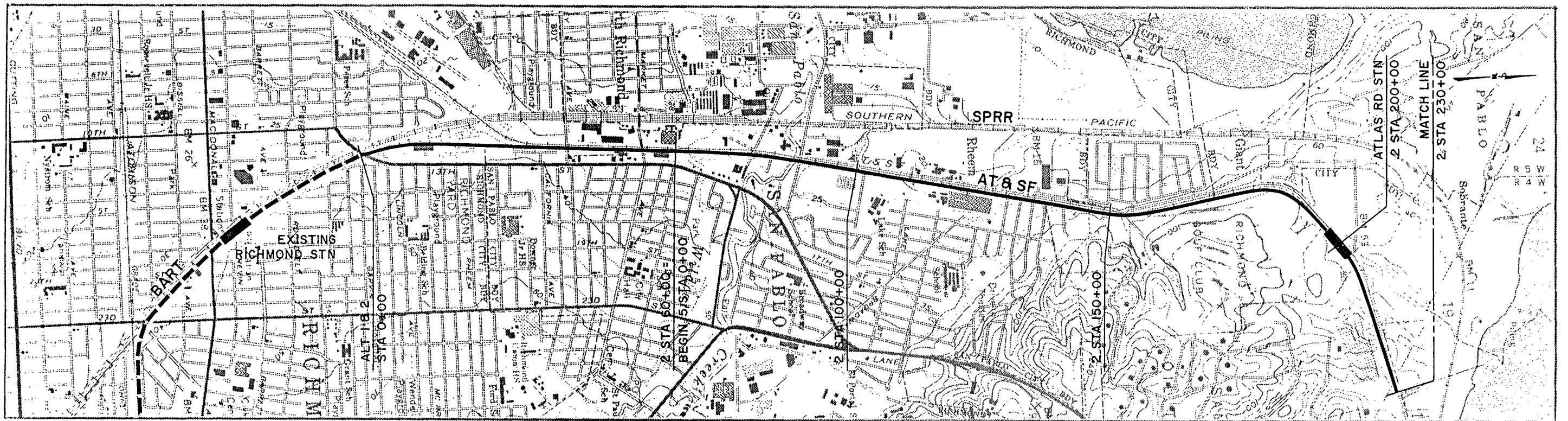
240

240



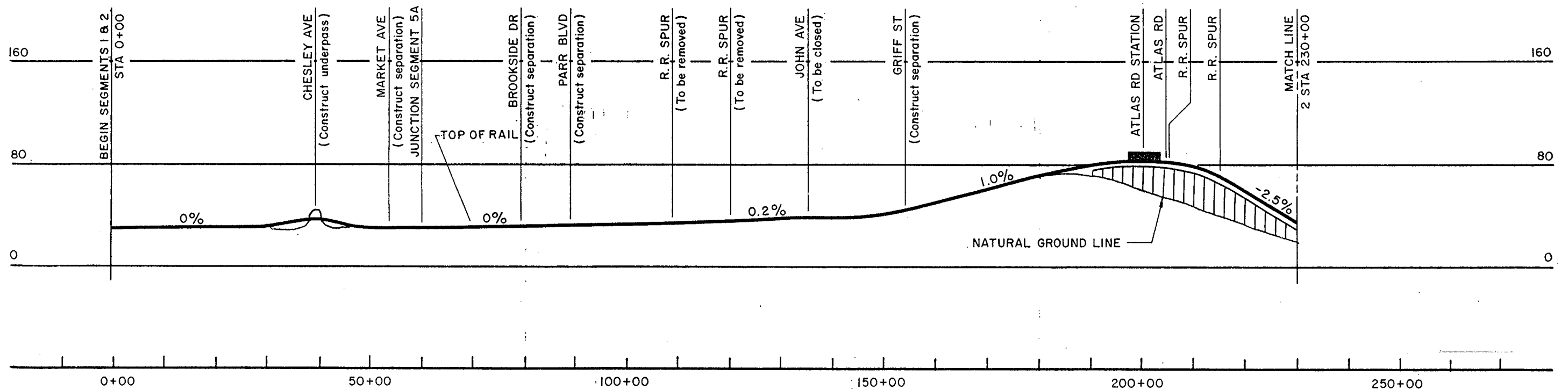
ALIGNMENT ALTERNATIVE I
PARALLELING THE SOUTHERN PACIFIC R.R. LINE (Segment ID)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



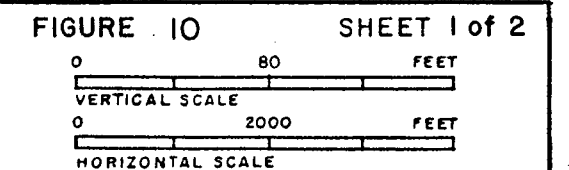


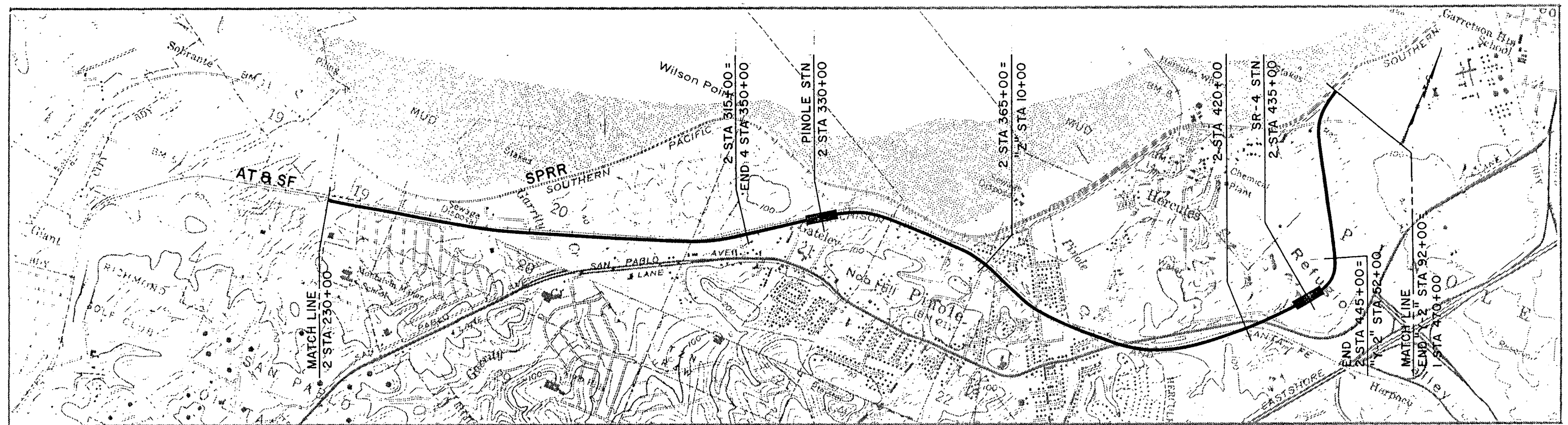
240

240



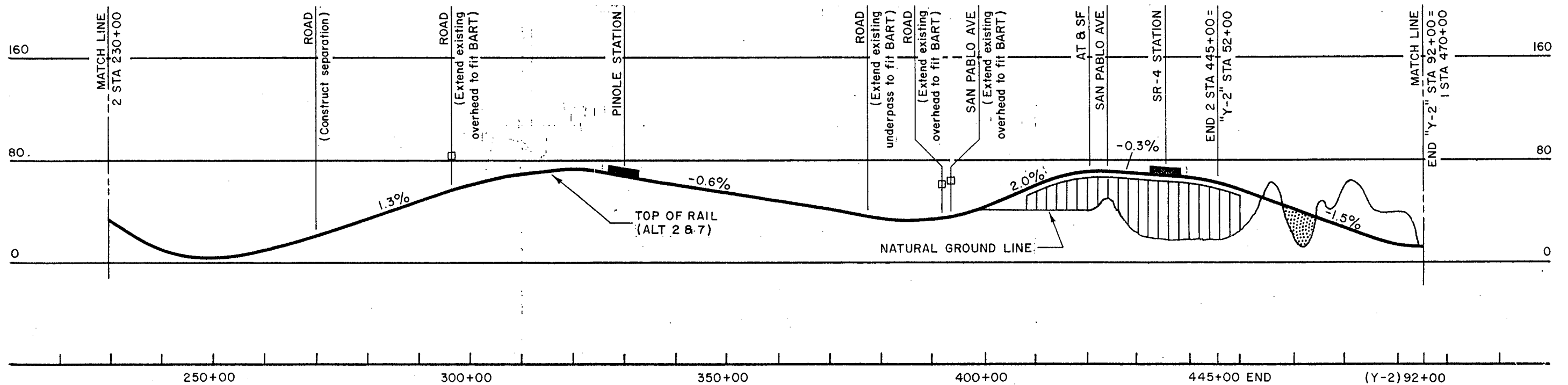
ALIGNMENT ALTERNATIVE 2 /14
PARALLELING THE ATCHISON, TOPEKA & SANTA FE R.R. LINE (Segments 2A, 2B)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



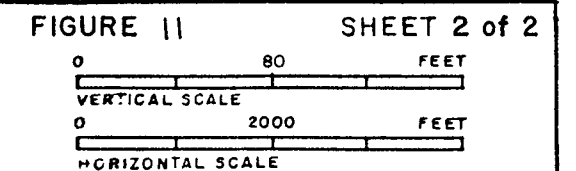


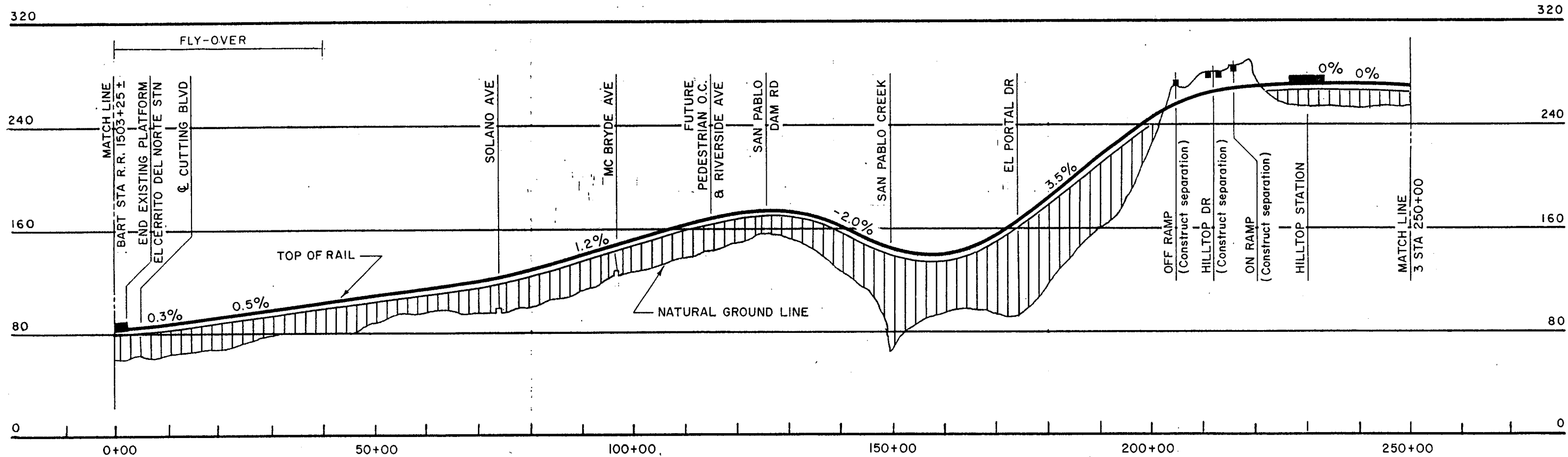
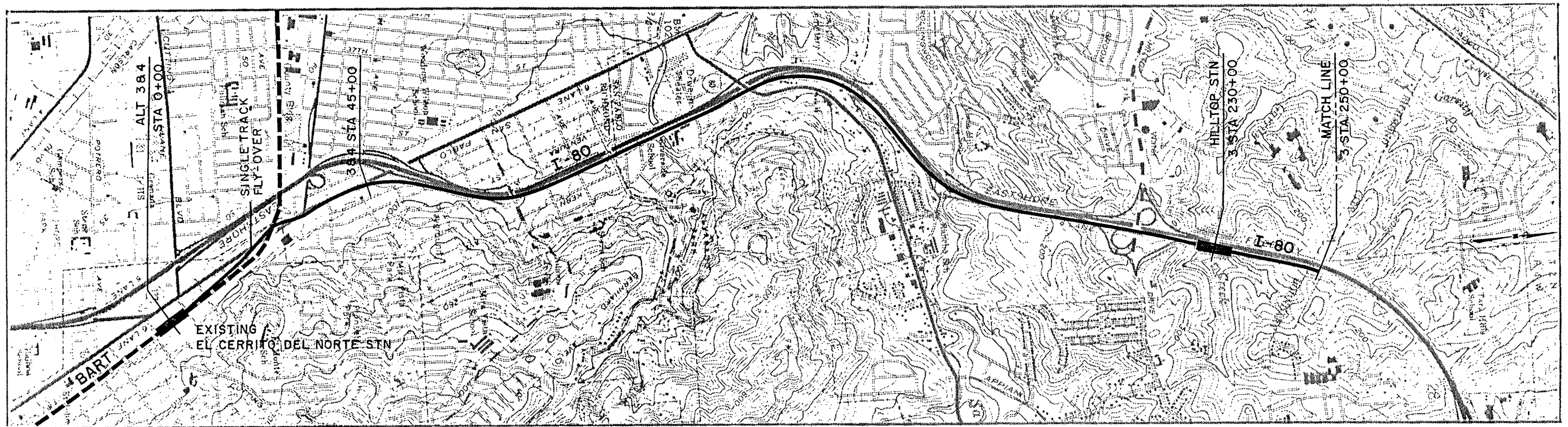
240

240

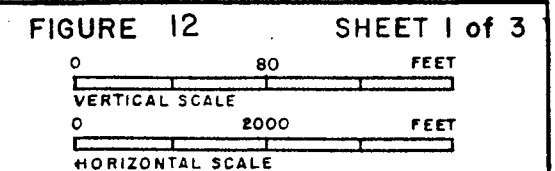


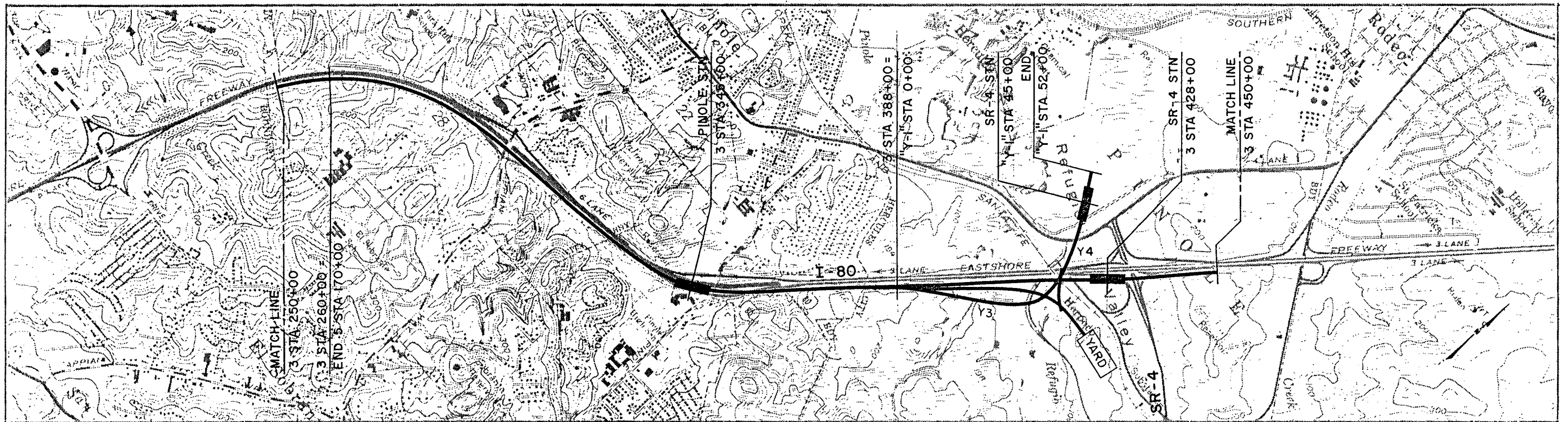
ALIGNMENT ALTERNATIVE 2/14
PARALLELING THE ATCHISON, TOPEKA & SANTA FE R.R. LINE (Segments 2B, 2C, 2D, 2E, Y-2)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY





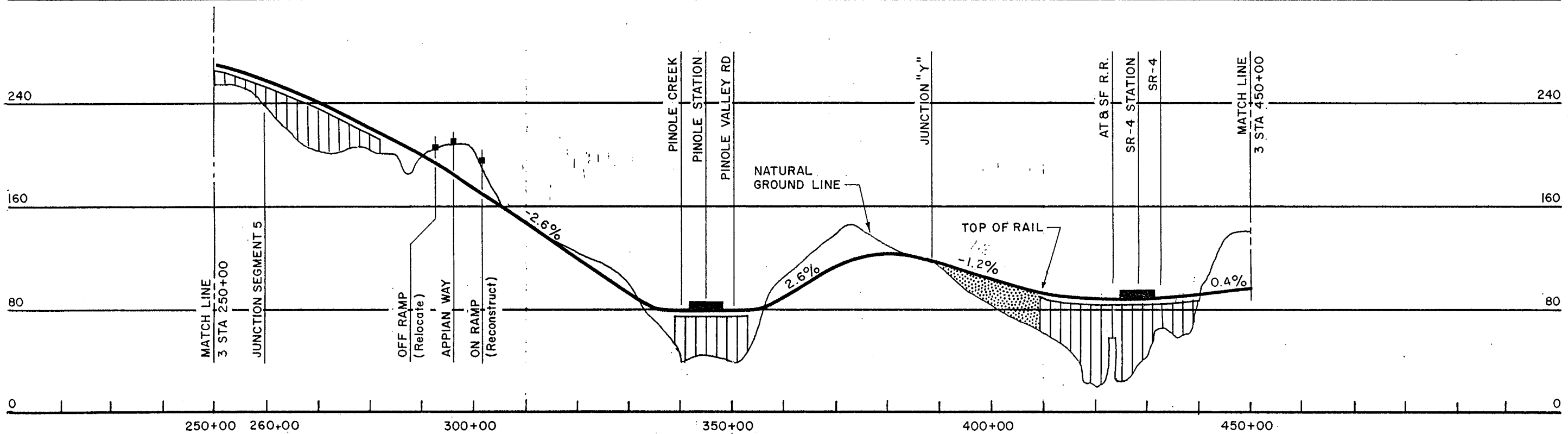
ALIGNMENT ALTERNATIVE 3
PARALLELING I-80 FREEWAY EAST SIDE (Segment 3A)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



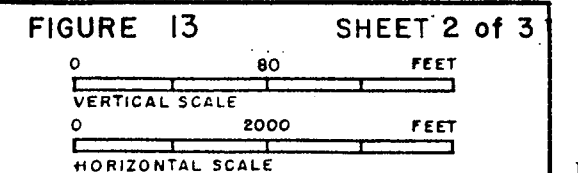


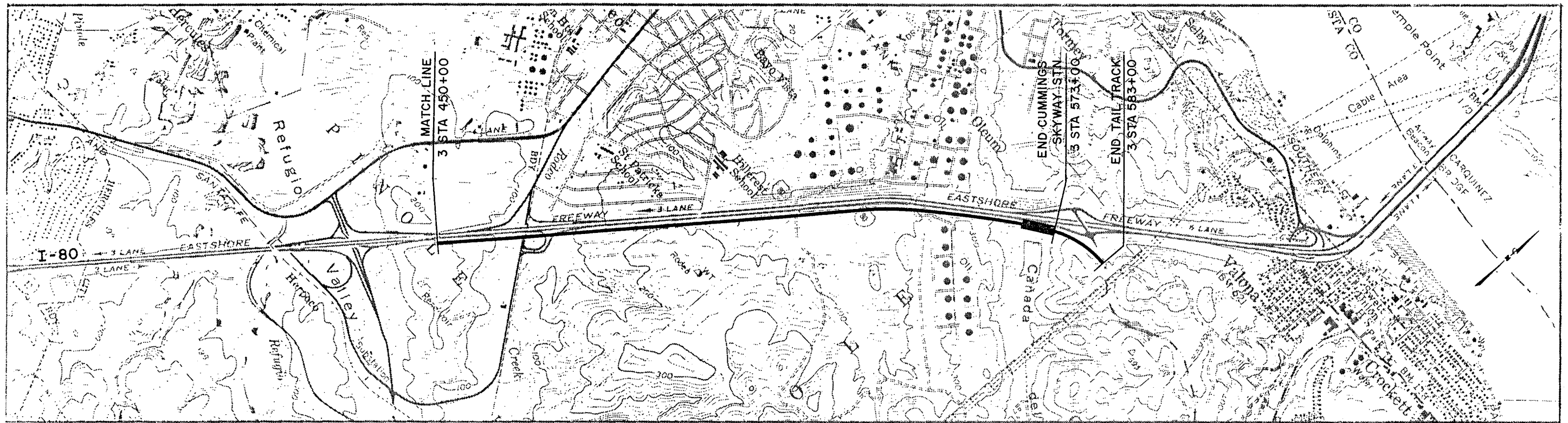
320

320



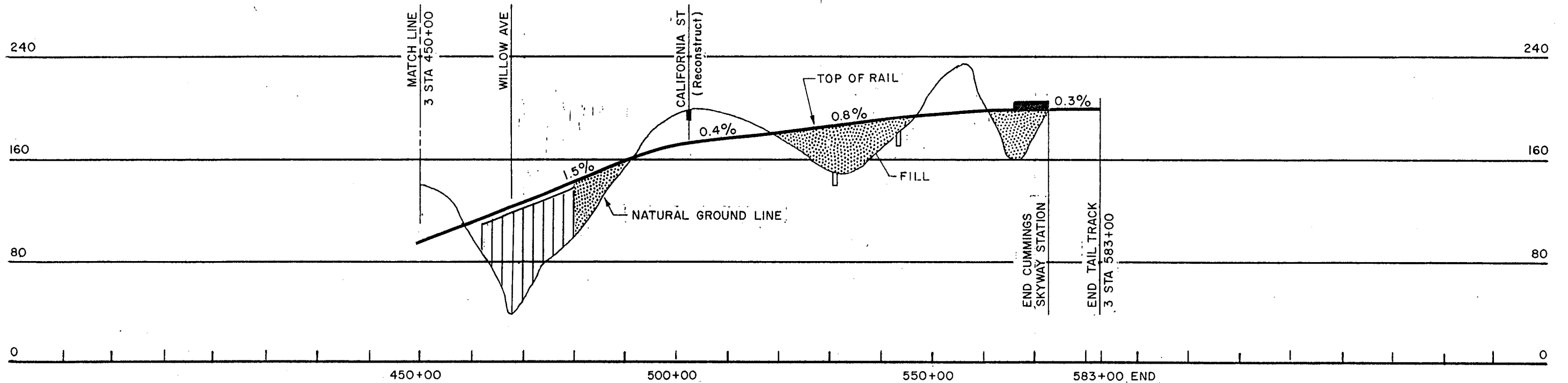
ALIGNMENT ALTERNATIVE 3
PARALLELING I-80 FREEWAY EAST SIDE (Segments 3A, 3B)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY





320

320



240

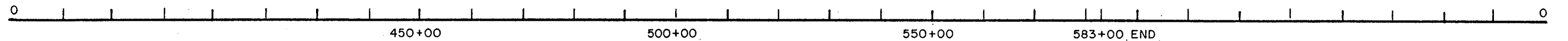
240

160

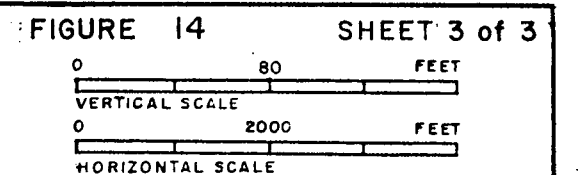
160

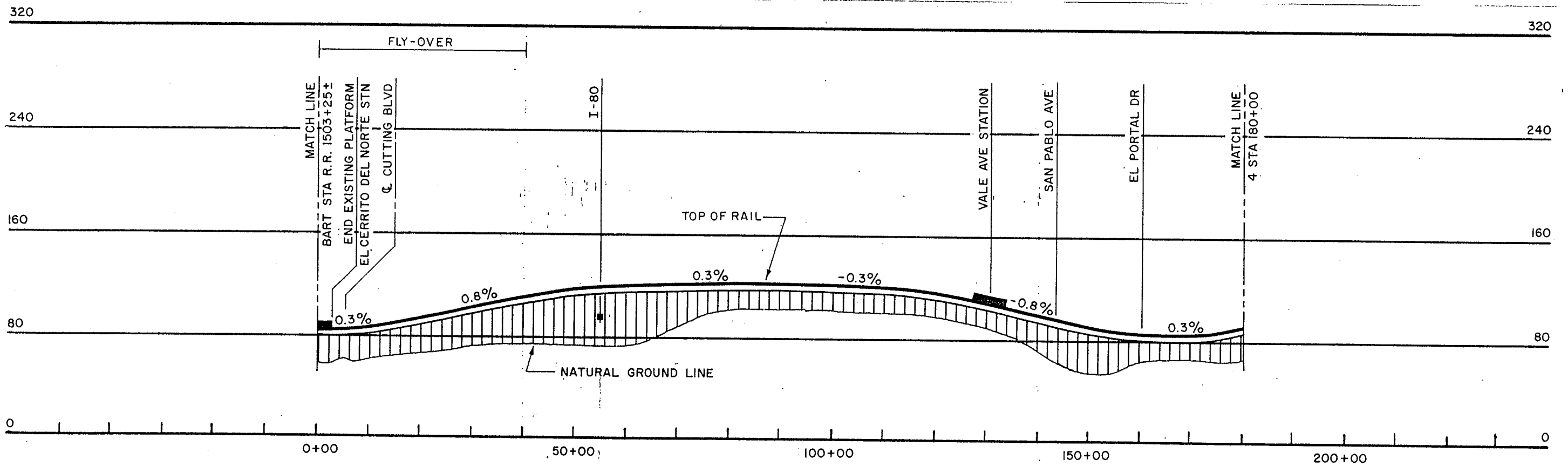
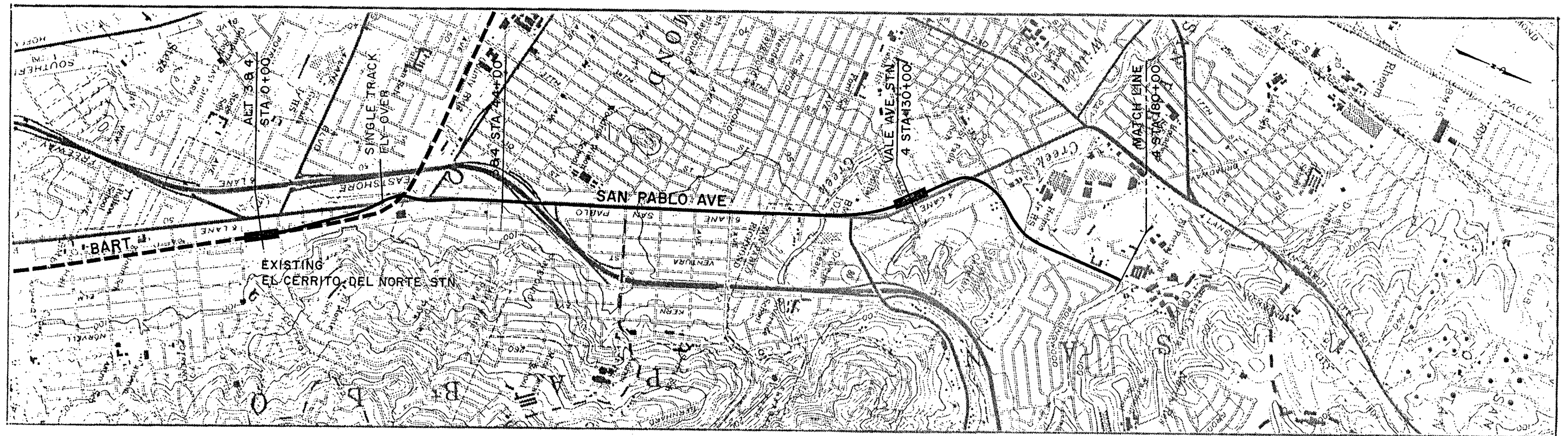
80

80

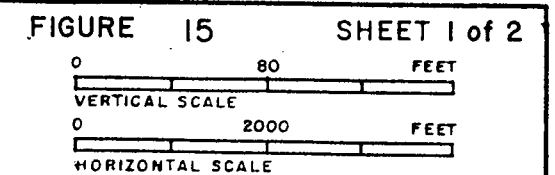


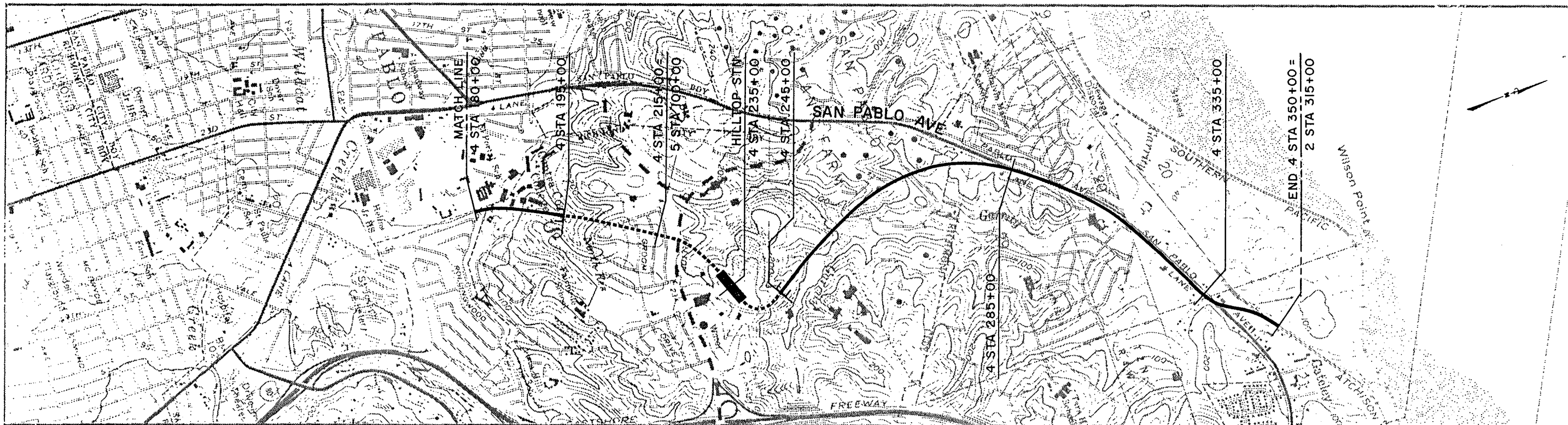
ALIGNMENT ALTERNATIVE 3
PARALLELING I-80 FREEWAY EAST SIDE (Segment 3C)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY





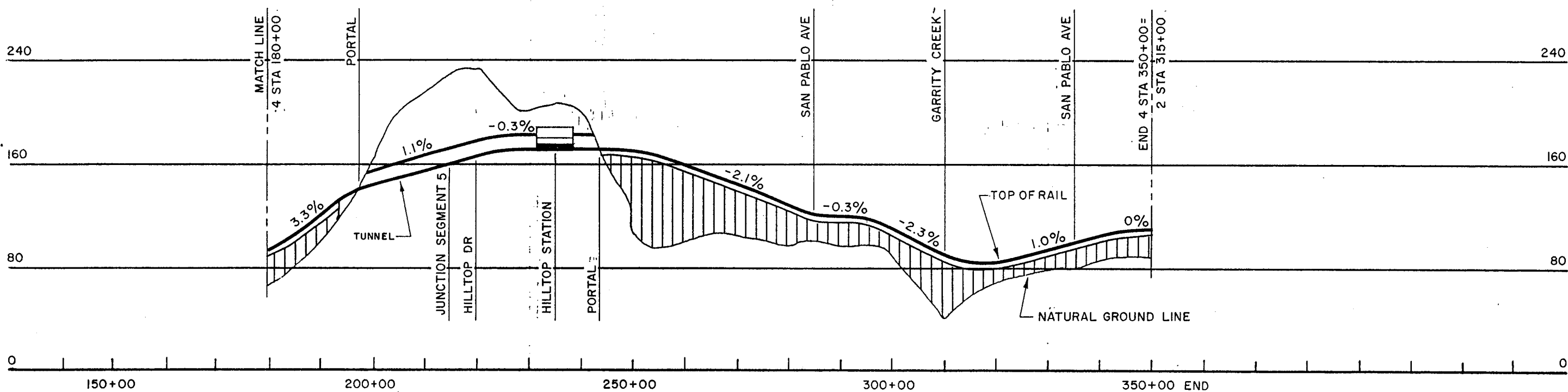
ALIGNMENT ALTERNATIVE 4
VIA SAN PABLO AVENUE TO HILLTOP MALL TO AT & SF R.R. LINE (Segment 4A)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



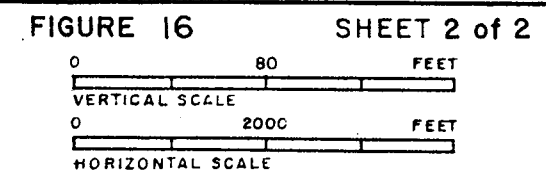


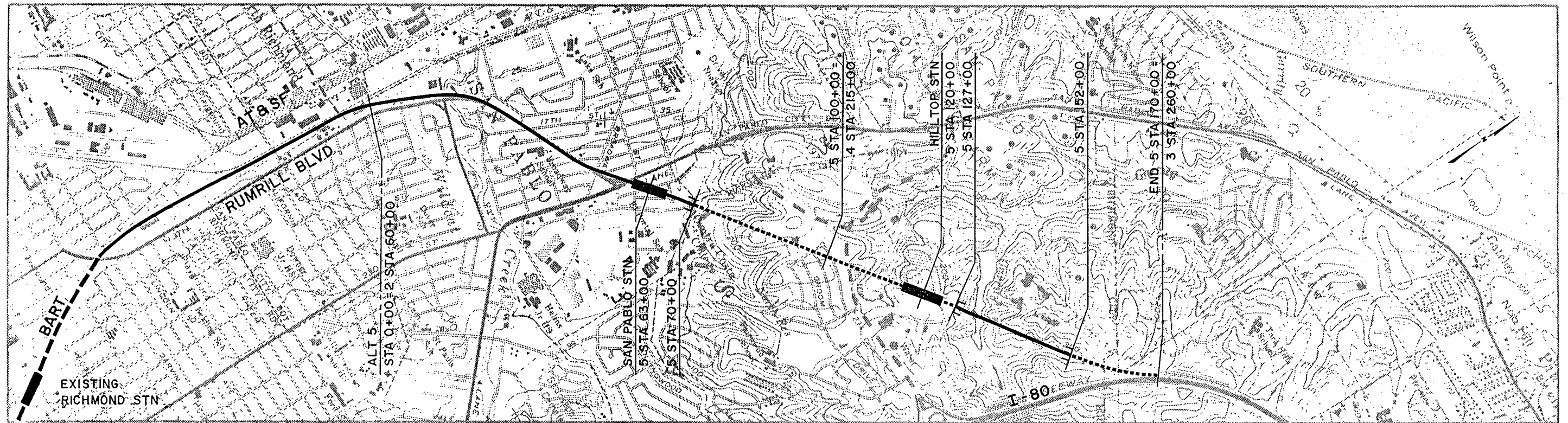
320

320



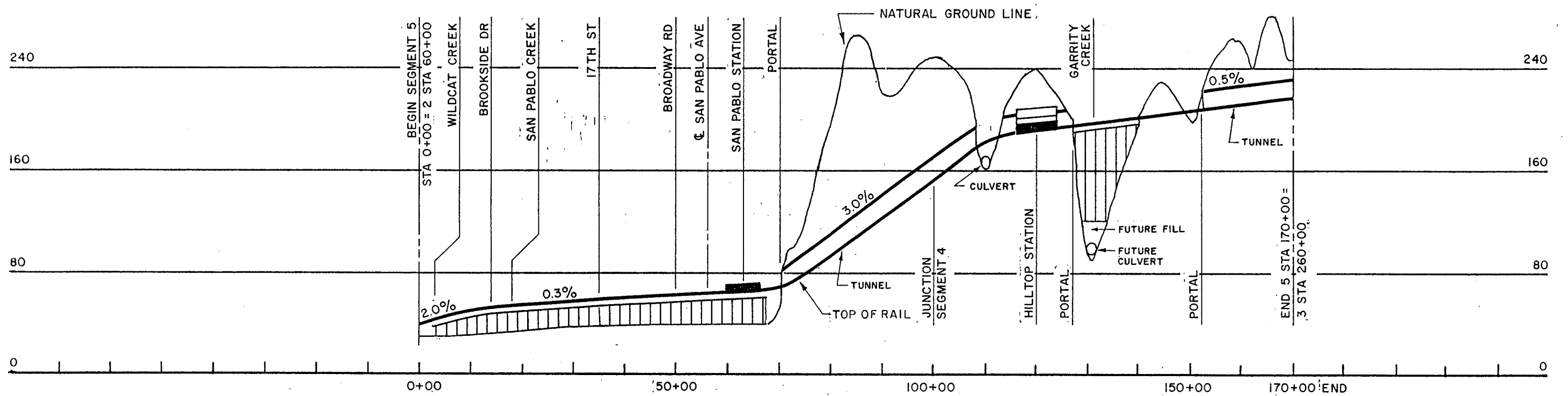
ALIGNMENT ALTERNATIVE 4
VIA SAN PABLO AVENUE TO HILLTOP MALL TO AT & SF R.R. LINE (Segment 4B),
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



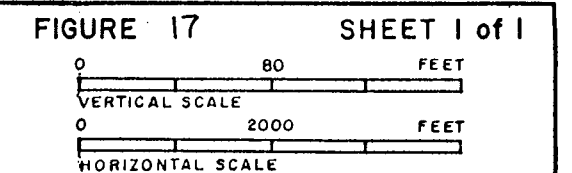


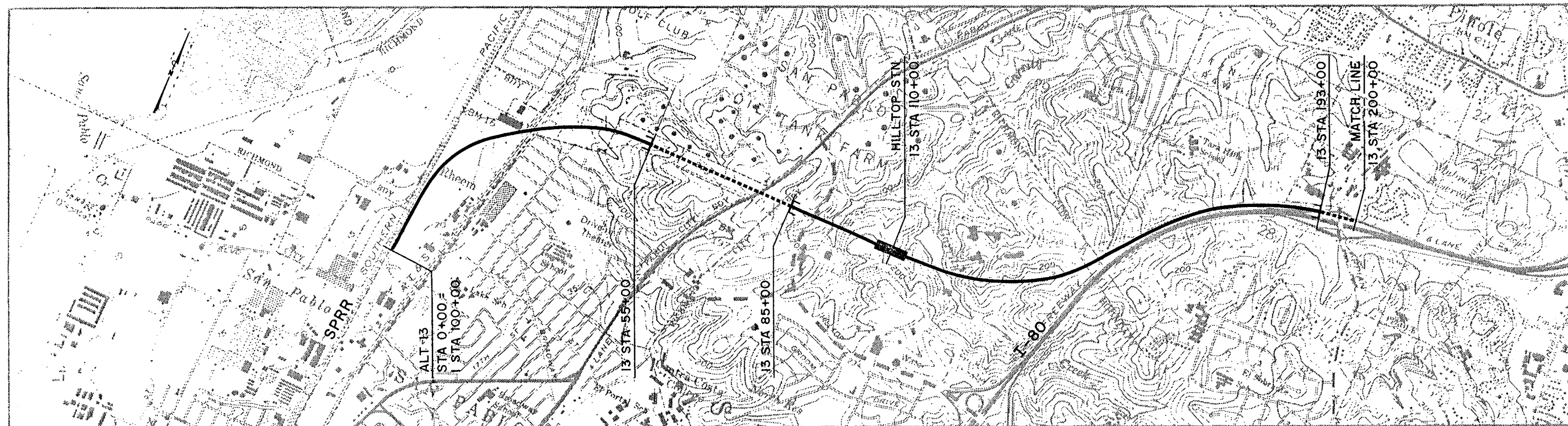
320

320



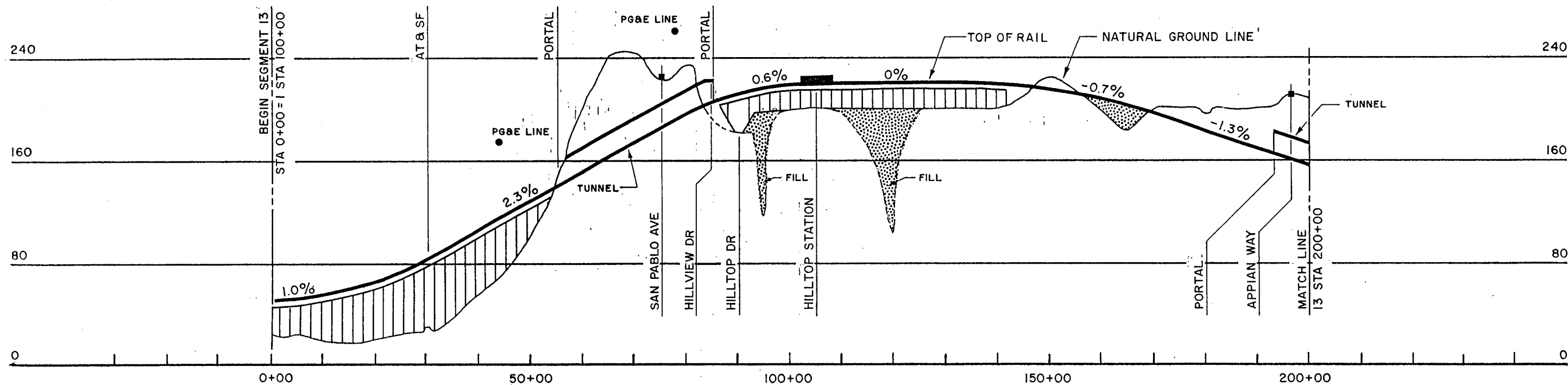
ALIGNMENT ALTERNATIVE 5
FROM AT&SF R.R. TO HILLTOP MALL VIA RUMRILL BOULEVARD (Segments 5A, 5B)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY



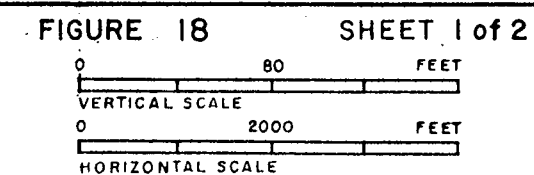


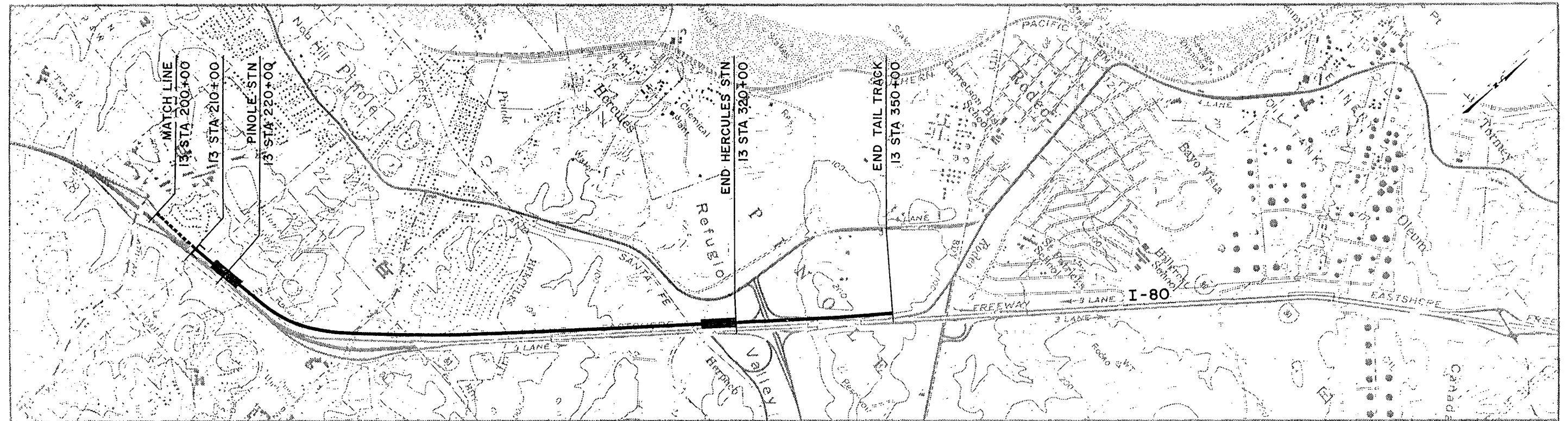
320

320



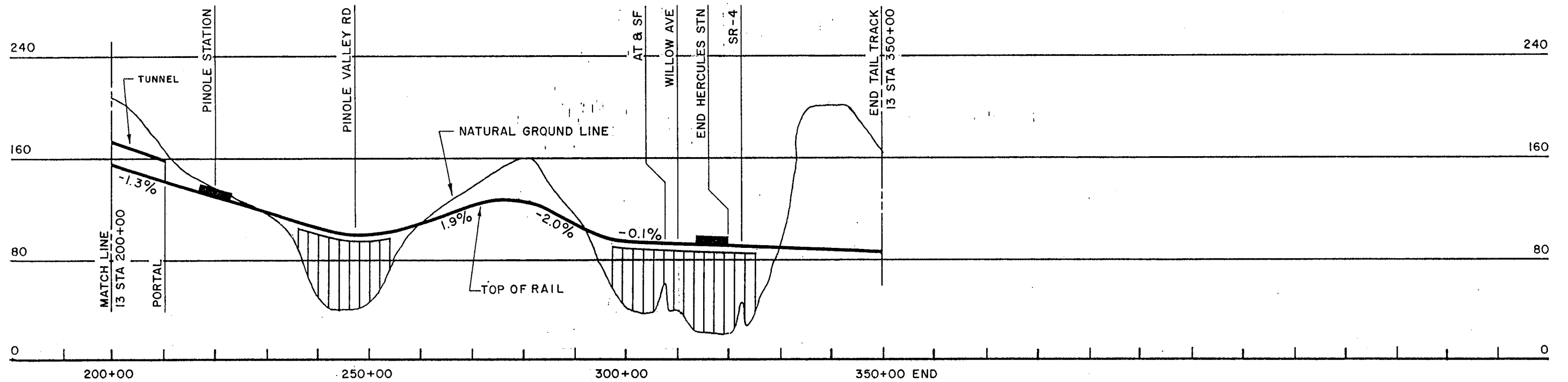
ALIGNMENT ALTERNATIVE 13
SOUTHERN PACIFIC R.R. LINE TO HILLTOP MALL TO I-80 FREEWAY WEST SIDE (Segments 1A/1, 13)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY





320

320



ALIGNMENT ALTERNATIVE 13
I-80 FREEWAY WEST SIDE TO SR-4 (Segment 13)
WEST CONTRA COSTA COUNTY BART EXTENSION STUDY

